The Welding Engineer

Founded by L. B. Mackenzie, 1916

JANUARY, 1927 VOL. 12, No. 1

$3.00 per year in U. S. 608 S. Dearborn St., Chicago, Ill. Reg. U. S. Pat. Office $4.00 per year abroad

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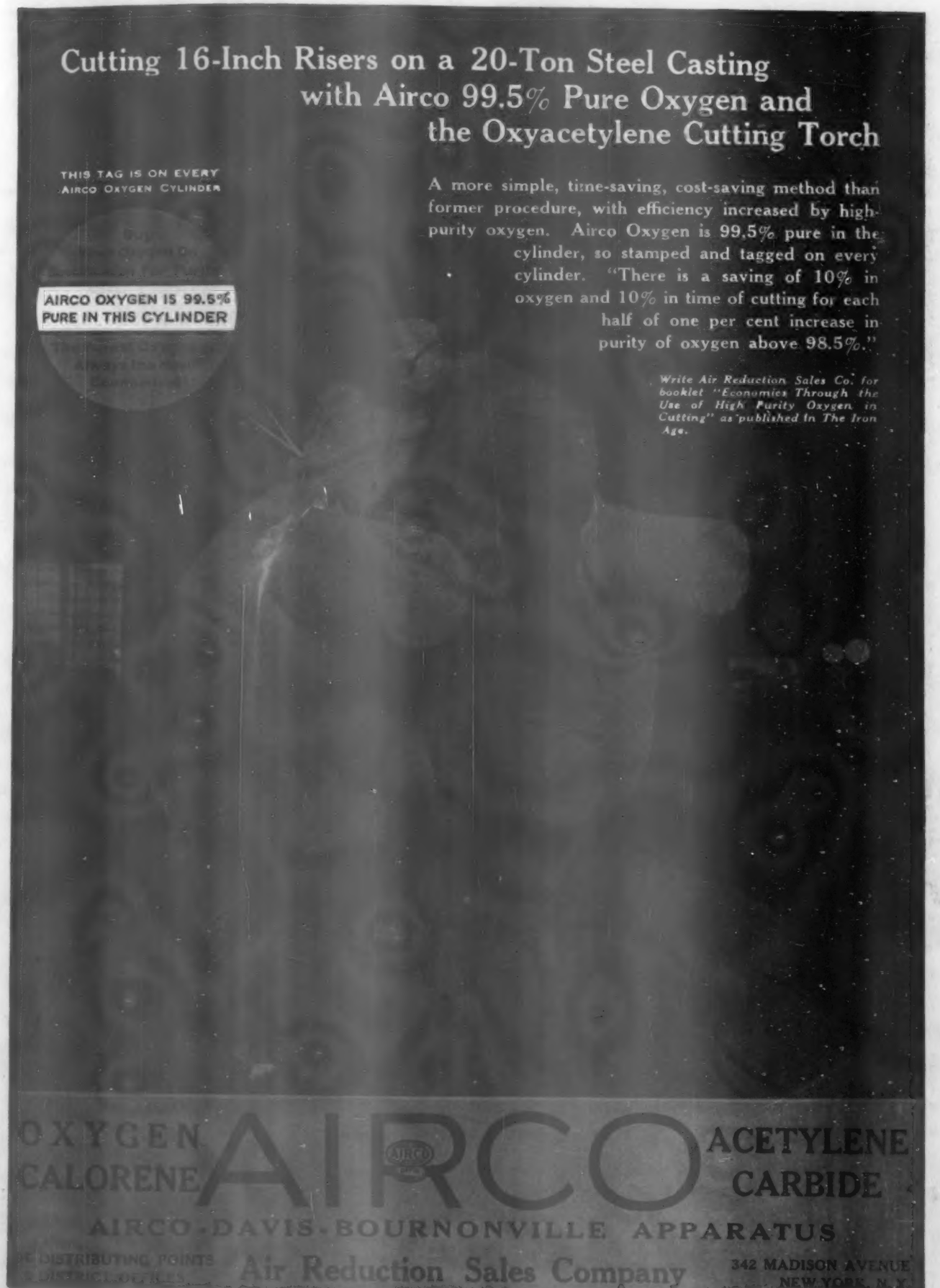

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DISSOLVED ACETYLENE

The Welding Engineer

Founded by L. B. Mackenzie, 1916

Volume 12 January, 1927 Number 1

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ONE of the important functions of these advertising campaigns which you follow through succeeding issues of your business paper is to protect you against the "just as good" argument. Once you have established a definite relationship between the trade mark, or trade name, the name of the advertiser, and the specific merits of the article advertised, it becomes increasingly difficult to change your buying convictions, whether the article purchased be grape fruit or welding rods. If the buyer stops to think what a great compliment is hidden in the phrase "just as good," he will keep on looking for the article of his original desire. The advertised article usually has points of particular merit, and the advertisement lists them so that consumers may select merchandise best suited to their individual requirements. Money would not be circulating so freely in this country today if advertising had not built up confidence in the minds of the buying public, and the advertisers been careful to deliver goods that would retain that confidence.

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The Welding Engineer does not publish in its news or advertising columns any matter that deals with or refers to either personal or legal controversies.

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SOUTH AFRICA—J. W. Arnison, 35a Victoria Ave., Benoni, Transvaal, South Africa.

Buyers' Index

Readers of The Welding Engineer will find this index to contain the most accurate information obtainable relating to welding apparatus and supplies. The advertising section includes the principal manufacturers of the United States.

ACETYLENE (Compressed in Cylinders)
Air Reduction Sales Co.
Commercial Acetylene Supply Co.
International Oxygen Co.
Prest-O-Lite Co.

ACETYLENE CYLINDERS
Keith Dunham Company
Pressed Steel Tank Co.

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ALUMINUM SOLDER
Aluminum Fix Co.
Weldene Corporation

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Westinghouse Elec & Mfg. Co

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Ideal Face Shield Co.

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See "Torches."

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Torchweld Equipment Co.
U. S. Welding Co.

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Steel Sales Corp.

BUFFERS
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N. A. Strand & Co.
Wodack Electric Tool Corp.

BUTT WELDERS
See "Electric Resistance Welders"

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Allan Mfg. & Welding Co.
Electric Arc Cutting & Welding Co.
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Quasi-Arc Weldtrode Co.
Seneca Electric Arc Welder Co.
Una Welding and Bonding Co.
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Wilson Welder & Metals Co.

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Shawinigan Products Corp.
Union Carbide Sales Co.

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Harris Calorific Co.
National Carbon Co.
Oxweld Acetylene Co.

CARBON BURNING EQUIPMENT
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Milburn, Alexander Co.
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Torchweld Equipment Co.

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Lincoln Electric Co.
National Carbon Co.
Una Welding and Bonding Co.
Westinghouse Elec. & Mfg. Co.
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Pressed Steel Tank Co.

CYLINDERS (Oxygen, Hydrogen)
Wm. Wharton, Jr. Co.

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See "Cutting Electrodes"

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Lincoln Steel Co.
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Welding Service Co.
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Wilson Welder & Metals Co.

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Elkon Works, Inc.

ELECTROLYTIC OXYGEN AND HYDROGEN GENERATING EQUIPMENT
International Oxygen Co.

FACE SHIELDS (Arc Welding)
Allan Mfg. Co. & Welding Co.
Burke Electric Co.
Chicago Eye Shield Co.
Electric Arc Cutting & Welding Co.
Electric Welding Machine Co.
Fibre-Metal Products Co.
General Electric Co.
Gibb Welding Machines Co.
Grindle Electric Welder Co.
Harms & Co.
C. H. Hollup Corp.
Ideal Face Shield Co.
Lincoln Electric Co.
Monarch Electric Welder Co.
Northwestern Mfg. Co.
Owen Electric Mfg. Co.
Quasi-Arc Weldtrode Co.
Seneca Electric Arc Welder Co.
Strauss & Buegeleisen
R. D. Thomas Co.
Una Welding and Bonding Co.
Westinghouse Elec. & Mfg. Co.
Wilson Welder & Metals Co.
Willson Goggles, Inc.

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Air Reduction Sales Co.
American Brass Co.
Central Steel & Wire Co.
Oxweld Acetylene Co.
C. H. Hollup Corp.
Imperial Brass Mfg. Co.
Lincoln Steel Co.
Page Steel & Wire Co.
Reid-Avery Co.
Roebling, John A., Sons Co.
Steel Sales Corp.
Seneca Wire & Mfg. Co.
Stulz-Sickles Co.
R. D. Thomas Co.
Torchweld Equipment Co.
Wickwire-Spencer
Welding Service Co.
Weldit Acetylene Co.

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Joseph Dixon Crucible Co.
National Carbon Co.
U. S. Welding Co.

FLUE WELDERS (Electric)
General Electric Co.

FLUXES
Air Reduction Sales Co.
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Metal & Thermit Corp.
Endress Mfg. Co.
Central Steel & Wire Co.
Oxweld Acetylene Co.
Torchweld Equipment Co.
Weldene Corporation
Weldit Acetylene Co.

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Harris-Calorific Co.
U. S. Welding Co.
Weldit Acetylene Co.

GLOVES (Asbestos)
Ideal Face Shield Co.

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National Gauge & Equipment Co.

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M. Keith Dunham
Imperial Brass Mfg. Co.
Milburn, Alexander Co.
Oxweld Acetylene Co.
U. S. Welding Co.

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Ideal Face Shield Co.
Strauss & Buegeleisen
Willson Goggles, Inc.

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Joseph Dixon Crucible Co.

GRINDERS (Portable Electric)
Mall Tool Co.
N. A. Strand & Co.
Wodack Electric Tool Corp.

Already a Great Success---

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A Brand New Product
from a Brand New Plant.

A Full Coated Electrode
at Bare Wire Prices.

Placed on the market to fill an urgent need by the welding industry for an electrode of absolute uniformity at a price.

This new rod is of .13-.18 Carbon, .40-.60 Manganese with all impurities under .04. This new rod has been developed primarily for direct current welding where bare wire has given uncertain results. Can be used with A. C. as well as D. C. We absolutely guarantee the uniformity and weldability of every rod in a fifty pound package. Prices and samples on request.

RACO COMPOSITE WIRE for Automatic Welding
RACO WHITE LABEL Pure Iron Electrodes
RACO PURE IRON COPPER COATED RODS
RACO MILD STEEL COPPER COATED RODS
RACO HIGH CARBON
RACO NICKEL STEEL
RACO BRONZE

REID-AVERY CO., INC.

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Chicago Eye Shield Co.
Electric Arc Cutting & Welding Co.
Electric Welding Machine Co.
Fibre-Metal Products Co.
General Electric Co.
Gibb Welding Machines Co.
Grindle Electric Welder Co.
Harms & Co.
C. H. Hollup Corp.
Ideal Face Shield Co.
Lincoln Electric Co.
Monarch Electric Welder Co.
Northwestern Mfg. Co.
Owen Electric Mfg. Co.
Quasi-Arc Weldtrode Co.
Seneca Electric Arc Welder Co.
Strauss & Buegeleisen
R. D. Thomas Co.
Westinghouse Elec. & Mfg. Co.
Wilson Welder & Metals Co.
Willson Goggles, Inc.

HYDROGEN
Gas Products Association
International Oxygen Co.

HYDROGEN GENERATING PLANTS
International Oxygen Co.

LEAD WELDING UNITS
Air Reduction Sales Co.
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Imperial Brass Mfg. Co.
International Oxygen Co.
K-G Welding & Cutting Co.
Milburn, Alexander, Co.
Oxweld Acetylene Co.
Torchweld Equipment Co.
U. S. Welding Co.
Weldit Acetylene Co.

LIGHTERS (For Gas Torches)
Air Reduction Sales Co.
Harris Calorific Co.
Imperial Brass Mfg. Co.
International Oxygen Co.
K-G Welding & Cutting Co.
Milburn, Alexander, Co.
Oxweld Acetylene Co.
Stevenson Distributing Corp.
Torchweld Equipment Co.
U. S. Welding Co.

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Harris Calorific Co.
Imperial Brass Mfg. Co.
International Oxygen Co.
K-G Welding & Cutting Co.
Milburn, Alexander, Co.
Oxweld Acetylene Co.
Torchweld Equipment Co.
U. S. Welding Co.

MECHANICALLY OPERATED CUTTING AND WELDING TORCHES
Air Reduction Sales Co.
Oxweld Acetylene Co.
Torchweld Equipment Co.

MOLDING MATERIAL
See "Fire Proof Plastic Material"

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Central Steel & Wire Co.
Wilson Welder & Metals Co.

NEEDLE VALVES
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Harris Calorific Co.
Imperial Brass Mfg. Co.
International Oxygen Co.
K-G Welding & Cutting Co.
Milburn, Alexander, Co.
Oxweld Acetylene Co.
Torchweld Equipment Co.
U. S. Welding Co.

NITROGEN
Air Reduction Sales Co.
Gas Products Association
Linde Air Products Co.
International Oxygen Co.

OXYGEN
Air Reduction Sales Co.
Gas Products Association
International Oxygen Co.
Linde Air Products Co.

OXYGEN PRODUCTION PLANTS
Keith Dunham Company
Heylandt Sales Co.

PREHEATING DEVICES AND OVENS
Imperial Brass Mfg. Co.
Metal & Thermit Corp.

RAIL BONDS
Una Welding and Bonding Co.

RAIL JOINT WELDERS
Una Welding and Bonding Co.

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N. A. Strand & Co.
Wodack Electric Tool Corp.

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Harris Calorific Co.
Imperial Brass Mfg. Co.
International Oxygen Co.
K-G Welding & Cutting Co.
Milburn, Alexander, Co.
Oxweld Acetylene Co.
Torchweld Equipment Co.
U. S. Welding Co.
Welding Service Co.
Weldit Acetylene Co.

SEAM WELDERS
See "Electric Resistance Welders"

SPOT WELDERS
See "Electric Resistance Welders"

TANK CONNECTIONS
Air Reduction Sales Co.
Harris Calorific Co.
Imperial Brass Mfg. Co.
International Oxygen Co.
K-G Welding & Cutting Co.
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Oxweld Acetylene Co.
Torchweld Equipment Co.
U. S. Welding Co.

THERMIT WELDING
Metal & Thermit Corp.

TORCHES (Welding and Cutting)
Air Reduction Sales Co.
Harris Calorific Co.
Imperial Brass Mfg. Co.
International Oxygen Co.
K-G Welding & Cutting Co.
Milburn, Alexander, Co.
Oxweld Acetylene Co.
Torchweld Equipment Co.
U. S. Welding Co.
Welding Service Co.
Weldit Acetylene Co.

TRUCKS (Cylinder)
Air Reduction Sales Co.
Imperial Brass Mfg. Co.
International Oxygen Co.
Torchweld Equipment Co.

VALVES
Air Reduction Sales Co.
International Oxygen Co.

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Air Reduction Sales Co.
Harris Calorific Co.
Joseph Dixon Crucible Co.
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SWEDOX

WELDING RODS, WIRES and ELECTRODES

SWEDOX Welding Rods and Wires, differing widely in chemical and physical properties, have one common quality. Each brand is made for a particular welding requirement.

When you consider the care that must be exercised in the selection of metal for different construction requirements, it becomes apparent that equal care is necessary in selecting filler material for welding the joints in these constructions.

The SWEDOX line has been developed so as to furnish on each welding job the welding wire which will enable the welder to get the most satisfactory result. There is a SWEDOX wire for your work. Try it, and you'll know why SWEDOX customers come back.

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Lafayette 8500

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5001 Bellevue Ave.
Lincoln 6700

Main Warehouses and General Offices, Central Steel & Wire Co., Chicago.

Every Welder's Library

If You Haven't Read This Page Before, Do It Now—
Getting the Most Out of Your Work Means Constant Study

The Welding Encyclopedia, by Mackenzie and Card, is written for you men who want to know all about welding. It not only solves your welding problems but will also give you a fund of welding knowledge which will increase the efficiency of your shop. Its contents cover in detail all phases of autogenous welding, and in addition many useful charts, tables, rules, regulations, etc. 435 pages, 375 illustrations, bound in black imitation leather. Price $5.00.

Automobile Welding with the Oxyacetylene Flame, by M. Keith Dunham. Explains in a simple manner the apparatus to be used, its care, and how to construct the necessary shop equipment. Tells how to weld all automobile parts in a manner understandable by anyone. 167 pages. 66 illustrations. Pocket size. Price $1.50.

Electric Welding, by Erik Oberg—A practical book that embodies the results obtained and the methods used by the most prominent concerns in the United States. 295 pages. Fully illustrated. Gives the data and information on electric welding that the man in the machine building shop requires. Price $3.50.

Oxyacetylene Welding Manual, by Lorn Campbell, Jr.—A book of instructions for the beginner. Treats of welding cast iron, steel, aluminum and malleable iron, cutting, preheating, and carbon burning. 172 pages. 92 illustrations. Price $1.50.

Electric Welding, by Ethan Viall—The uses and principles of construction of arc welding equipment. Automatic welding, butt welding and spot welding. Illustrations and descriptions of many commercial machines. 417 pages, 329 illustrations. Price $4.00.

Gas Torch and Thermit Welding, by Ethan Viall —The book describes in detail just how to make every common type of weld. Many American made torches are shown and described. Two special chapters are devoted to mechanical details of machines for gas welding and cutting. 434 pages, 342 illustrations. Price $4.00.

Electric Arc Welding, by E. Wanamaker and H. K. Pennington. The book covers descriptions of welding systems and their installations, phenomena of the metallic and carbon welding arc, training of operators, methods for applying metal to various types of joints and building-up operations, electrode materials used, weldability of various metals, weld composition, thermal disturbances of parts affected by the welding process, physical properties of completed welds, efficiency of welding equipments, welding cost, etc. 254 pages, 167 illustrations. Size 5 in. x 9 in. Bound in cloth. Price $4.00.

Arc Welding Hand Book—"The Arc Welding Hand Book," by C. J. Holslag, Chief Engineer, Electric Arc Cutting & Welding Co. This book is comprised of 250 pages and numerous illustrations. It is intended to serve as a simple and practical instruction in arc welding, and an attempt has been made to describe the methods, step by step, so that the beginner may understand both the equipment and the process. Price $2.00.

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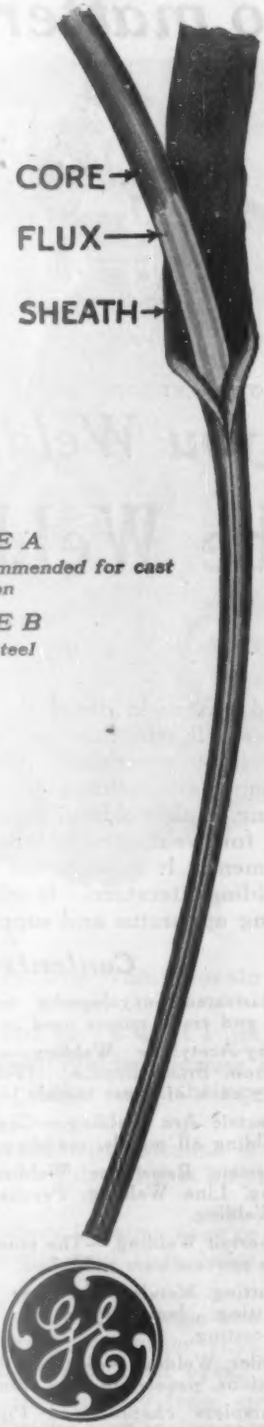

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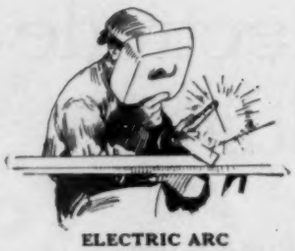

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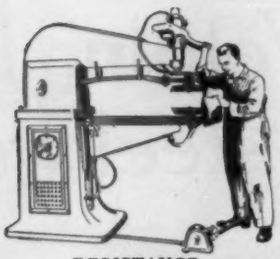

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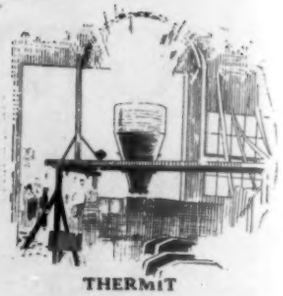

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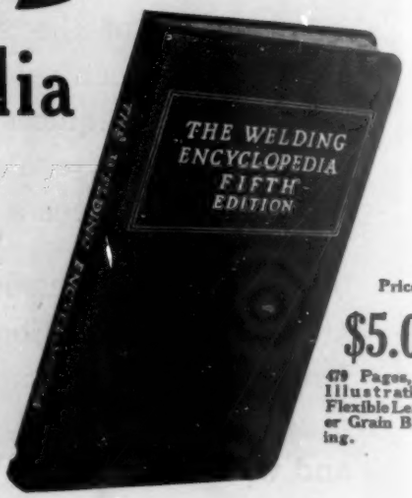

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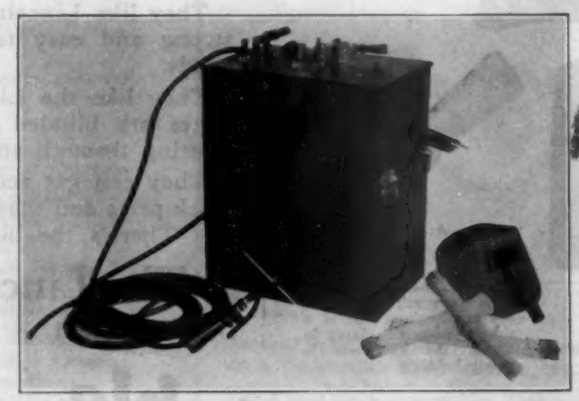

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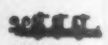
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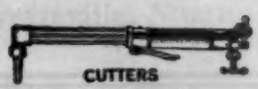
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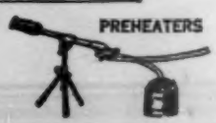
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Sweeney Auto School,
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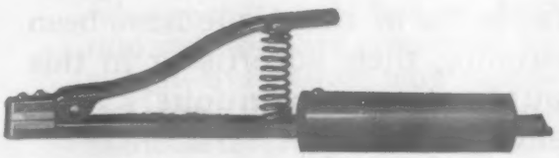

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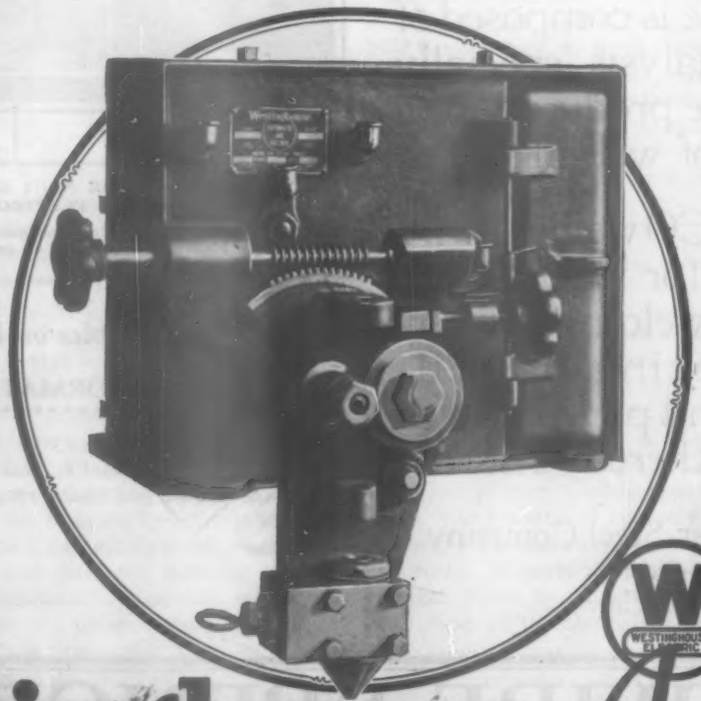

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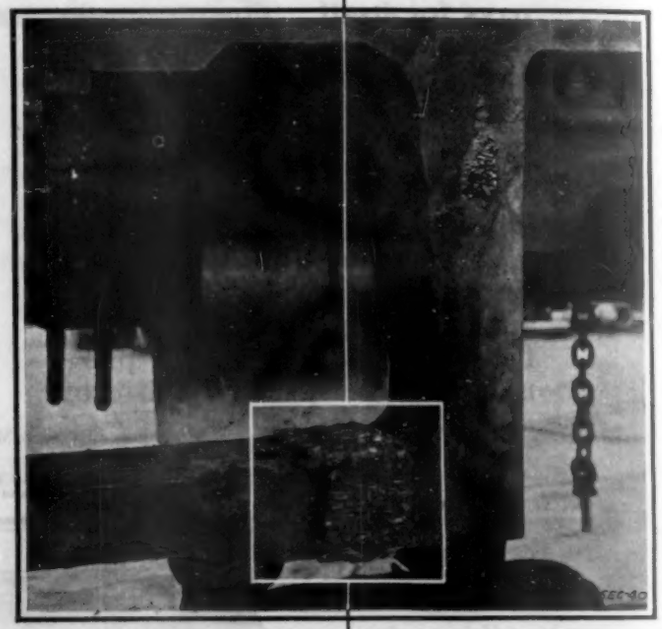

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WICKWIRE SPENCER *PRODUCTS*

EDITORIAL

No Process Is Totally Lacking in Weakness

NOW that the engineering profession is thoroughly aroused to the importance of learning more about "this welding business," it is well to be able to compare welded structures with other types of structures which they accept as conventional and proper. The story of concrete has often been mentioned in papers on welding, but there has probably never been a more interesting comparison of steel and concrete made than in Professor George F. Swain's paper before the American Institute of Steel Construction at White Sulphur Springs last October. Thousands of copies of this paper have been requested for distribution, and Mr. C. F. Abbott, executive director of the Institute points out that the reputation and fine attainments of the speaker are such as to justify a most careful study of this address by all persons who are concerned with construction. We find in the paper a list of thirteen causes of defective concrete and failure, with the statement that there may be others. The welding industry has no quarrel at all with concrete, nor any desire to pick flaws in it, but it does bespeak the same tolerance and acceptance for welded construction, and invites such investigation as will prove that the acceptance is deserved. One group of investigators within the industry has made a beginning at compiling real engineering data on welded joints. It happened that one series of tests provided a direct comparison between the variation in the quality of welded joints and the quality of the finest plate steel, and showed that the best of steel will show as much variation as welded joints made under reasonable supervision will show. Doesn't this suggest that the most stubborn resistance to the acceptance of welding may be overcome by comparing it with accepted processes and materials directly, instead of bickering and squabbling about a few superstitions and points of controversy that take up valuable time in technical discussions?

Welding Progress in 1926

WHATEVER the totals may look like when the last income tax reports are signed and delivered on the afternoon of March 15th, the records already show some fundamental gains made during the past twelve months. Manufacturers of apparatus and supplies may look at these gains as pointers to new and bigger markets. Users of welding may look at them as promises of further economies made possible. Welders may look at them as signs marking opportunities for better opportunities and better paying jobs. The point of view varies, but the story of welding progress in 1926 is encouraging to the entire industry. The progress has not been confined to the development and perfection of new processes and new applications. There has been enough of that to make the future look rosy, but by itself it would have left much work to be done. The satisfying gain has been made in securing acceptance for welding. Doors have been opened, which had remained stubbornly shut while the pioneers worked, and men who had been too busy with the things they knew to investigate the unknown, now demand to be shown more. There is a demand for men who can make users out of these information seekers, and the industry finds itself away behind schedule in the production of skilled salesmen. This greater acceptance of welding has developed as a result of the splendid achievements of the workers in the industry, so all credit must be given them for their share, but the acceptance must come before sales and profits start, therefore it looms up as a significant feature of the picture. To capitalize in 1927 the acceptance secured in 1926, in new business, is a year's work for all the sales forces. However, experience suggests that some progress will be made in other directions also.

A Training Suggestion

IN ALL cases where the shop or factory seems to be continually in need of training new men it ought to prove worth while to keep on hand samples of both good and poor workmanship done under actual shop conditions, the good samples to serve as a model and the poor ones labeled to show the cause of defects. Telling the beginner what is wrong is only going half way. To be convincing we must show him why it is wrong, in terms of results. Don't expect him to understand the terms that are so familiar to you and so new to him, and don't depend on pictures too much. Show him the real article. Call him in the next day and ask him to show you all he learned. This is a good check on what kind of a teacher you are.

Will the A. S. M. E. Boiler Code Be Changed

FOR years the activity on the subject of pressure vessel welding has had all the earmarks of a pitched battle. It couldn't be done and it could be done. It wasn't done and they were doing it. Impatience has been struggling with caution, with the latter holding fast. The unwarranted restrictions have been a source of irritation, and it has called for strong effort as well as heavy expense to gain a new foothold from which to work forward. Now the exponents of welding seem to be on the verge of accomplishing their desires. There seems to be little doubt about the possibility of revising the present code so as to remove some of the restrictions which have been so unwelcome. In time we may hope to see it become entirely reasonable.

Welding for the Engineering Student

SEVERAL reports have been grouped together in this issue, telling of the activities in welding in engineering schools in different localities. This is giving our future engineers a chance to study welding while they have access to fundamental information which has a considerable bearing upon the details of the theory and application. More and more of these young men who are of the inquisitive type may thus be interested to start investigations which might not attract them later. (As a matter of fact only a part of the scientific investigation of welding subjects that has been going on has been reported.) More of it should develop when the students are brought closer to the subject and become better acquainted with some of the fascinating fields of study which it offers. The questions yet unanswered will take them far into the fields of mechanics, physics, chemistry and metallurgy. The end of the beaten path is soon reached, and there is enough pioneer work to suit the most adventurous investigator. One student last year went back to an older thesis on riveted joints and prepared a new thesis on the strength of welded joints of the same design. His conclusions were a strong recommendation for welding, and may be taken as unprejudiced. Let this good work go on.

Oxweld's Banner Year

1926 was the biggest year in Oxweld's history and Oxweld is proud of it. This means that the reputation established by Oxweld equipment during the last fourteen years is substantial.

And in 1927 more people than ever before will buy Oxweld injector blowpipes, Oxweld regulators, Oxweld welding rods and fluxes.

These increased sales demand increased service. Oxweld is to give increased service to greater numbers than ever before—service that will help them use Oxweld equipment efficiently and economically.

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WELDING AND CUTTING APPARATUS

Pipe Is Bronze Welded at Foundry

Pipe Manufacturer Recommends That Bronze Welds in Cast Iron Pipe Be Made at Foundry Under Control

HAVING satisfied themselves as to the efficiency of bronze welded joints for cast iron pipe, the American Cast Iron Pipe Company of Birmingham, Ala., have for some time been marketing their pipe already welded into long lengths ready for laying. The story of this development is an interesting one owing to the great care which has been exercised to check each detail involved in the process. The subject of welding was first investigated in connection with attempts to develop a joint that would be gas-tight under pressures of 60 to 100 pounds per square inch. After some experimenting with cast iron welding investigation was broadened to include the study of bronze welding as applied to this work. Experiments indicated clearly enough that the process could be used to produce continuous lines of cast iron pipe which would be strong and perfectly tight. It was also learned that surface conditions made it inadvisable to weld such lines completely but that it was necessary to use mechanical points at regular intervals in the line to allow for expansion and contraction.

Cast Pipe Bronze-Welded Into Long Sections.

Welders Are Specially Trained For This Work.

The subject of corrosion was carefully considered and while investigating it the metallurgical phases of the point between bronze and cast iron was studied.

"Specials" That Are Strong And Tight.

The next important item on the program was the development of satisfactory technique. It was decided that the most desirable type of joint was that known as the bronze collar joint, in which the ends of the pipe are not beveled before welding.

An elaborate series of tests led to the following conclusion regarding procedure: The width of the bronze weld should vary in direct proportion to the thickness of the cast iron pipe and for a maximum strength this dimension should not be less than 1½ times, nor more than 1¾ times, the thickness of the pipe. The size of the welding flame and the manner of applying the heat should be so regulated as to cause a brazing or tinting of the cast iron surface without showing excessive color or heat either in the pipe metal or weld metal. The most desirable and strongest welds have been produced on pipe which the average time of welding was limited in minutes to less than twice the outside diameter of the pipe. The average speed of applying the bronze should not approach a figure of less than approximately two linear inches per minute. The bronze welded joint on cast iron pipe grows constantly stronger up to two or three hours from the time it is completed. Care should therefore be taken to prevent overstrains in the metal, especially in the short interval of time directly succeeding the completed work of making the bronze weld.

Close-Up of Welded Manifold.

The following table was compiled as a guide for welders applying bronze to cast iron pipe.

The two most important factors in getting 100 per cent bronze welded cast iron pipe are first thorough cleaning of the pipe surfaces to which the bronze is to be applied and second the speed with which the operator carries on his work.

TABLE 1
PRACTICAL BRONZE WELDING DATA

Nominal Diameter of Pipe Inches	Thickness Class A Pipe Inches	Ideal Width "W" Inches	Ideal Time of Welding Minutes	Ideal Thickness "T" Inches
2 in.	0.25	0.40	0.61	4.0
3 in.	0.39	0.60	0.082	6.5
4 in.	0.42	0.65	0.091	8.0
6 in.	0.44	0.67	0.094	11.0
8 in.	0.46	0.71	0.098	15.0
10 in.	0.50	0.75	0.105	18.0
12 in.	0.54	0.82	0.114	21.0
14 in.	0.57	0.86	0.121	24.0
16 in.	0.60	0.91	0.127	28.5
18 in.	0.64	0.97	0.135	31.0
20 in.	0.67	1.03	0.142	34.0
24 in.	0.76	1.15	0.161	41.0
30 in.	0.88	1.35	0.186	50.0
36 in.	0.99	1.55	0.211	60.0
42 in.	1.10	1.67	0.232	75.0
48 in.	1.26	1.92	0.270	85.0

All these investigations and experiments have shown two things very clearly: first, that cast iron pipe lines can be successfully welded with bronze; and second, that this is a special kind of work requiring a special technique in its application. The American Cast Iron Pipe Company therefore could supply customers with the pipe already welded, and

Tighter Joints at Less Cost.

welded under supervision which would make satisfactory work possible. Some of the literature of the company strongly recommends the use of pipe joined in this way. The following is quoted from one of their recent publications:

"Bronze welding of cast iron pipe is an established practice. Experience has shown that the most economical and satisfactory method is to do the bronze welding at the pipe foundry rather than in the field after the pipe is distributed along the trench. When welded at the foundry, the work is done under better conditions and by men who are skilled in the art.

"Any type of our small diameter cast iron pipe is furnished with five-foot plain-end sections bronze welded together to make a laying length per joint of 10, 15, 20, 25, 30, 35 or 40 feet. In ordering any of this material in these longer lengths be sure to specify fully the type of joint desired. This bronze welding is done at our foundry and when the long length pipe reaches the customer, it is handled and laid in just the same way as if it were cast in integral pieces.

"Numerous and exhaustive tests at our foundry have shown the bronze welded joint actually to be stronger than the pipe itself, and leak proof.

"The handling of long length small diameter pipe is not objectionable. Two men easily handle a 40-foot length of 2-inch pipe, the weight of which, including joint materials, is approximately 250 pounds. A 40-foot length of 4-inch pipe does not weigh as much as one piece of 8-inch, class "B," A. W. W. A., pipe 16-foot long. Of course, no trouble has ever been experienced in handling and laying standard 8-inch pipe, on account of its weight. It is necessary, in hauling these long lengths of pipe, only to make a long coupling on the wagon or attach a trailer to the truck. In hauling pipe long distances and over rough roads, some customers use a long piece of timber about 4x4 or 4x6 inches and the same length as the pipe, to which they anchor the pieces of pipe in the center to support them and protect them from jolts. Our experience has been, however, that in the many orders for long length pipe which we have furnished, the percentage of breakage in handling has been no greater than ordinary 12 or 16 foot pipe.

"It is unnecessary, of course, to dwell upon the speedy and economical field construction possible when using the longer lengths of pipe. The savings in construction costs on this account are very gratifying.

"Bronze welding is not confined to small diameter pipe by any means. Above four inch in diameter, however, the lengths usually are limited to twenty-four or thirty-two feet and in these lengths we have satisfactorily furnished orders of cast iron pipe in diameters as large as twelve inches.

"The art of bronze welding cast iron pipe has many possibilities. In the September issue of Pipe Progress were shown photographs and a description of some large manifolds made by bronze welding for a filtration plant."

With reference to the matter of getting satisfactory results on this work, Mr. H. Y. Carson, Research Engineer of the American Cast Iron Pipe Company, says:

"Our experience has been that men that were especially trained for bronze welding work and who had previously had very little general experience seem to get better results than those who have been old at the game. When a man has been welding on steel for several years, it seems to be difficult for him to get the idea of the lower temperatures at which bronze welding is carried on. He invariably overheats his work and otherwise continues to apply 'stunts' which he has learned in steel welding."

This opinion, based on so much experience with bronze welding on cast iron pipe, should be carefully observed by all welders who tackle this work for the first time. Other investigators and engineers have experienced the same difficulty with men who are new to the work, no matter how skillful they have proven to be in other kinds of welding. It would seem safe to say that no experienced welder can expect to get satisfactory results with bronze on cast iron unless he is prepared to forget all that he knows about welding other metals and approach this process with an absolutely open mind.

METAL TRADES ASSOCIATION TO ARRANGE WELDING TRAINING

The Chicago Section of the National Metal Trades Association is preparing a complete program of apprentice training for the benefit of its members. In the schedule which is being drawn up to cover this training work, complete courses are included in both oxy-acetylene welding and electric welding. The arrangements provide for a period of apprenticeship of three years, or thirty-six months, in each subject; and it is planned to make the course of training include as much lecture work and instruction work as possible, as well as practical shop work.

Theory of Arc Sputtering

Hypothesis Developed From Unrelated Experiments and Known Laws of Physics and Chemistry May Prove Valuable in Future Research

By J. B. Green*

NEARLY everyone who has seen metallic arc welding has wondered what causes the hissing, sputtering or cracking sounds as the case may be. It is doubtful whether a series of experiments could readily be devised which might definitely prove the cause, or, as is more likely to be true, the very many causes. However, there is another way of developing an hypothesis which may not be conclusively proved but still will be founded on fact and thus useful. Often a number of apparently unrelated experiments can be considered in conjunction with the known laws of physics and chemistry and a sound hypothesis developed by pure deductive reasoning which will be found very valuable. The hypothesis discussed in this article was developed in this manner.

Brillié's Experiment

M. Jean Brillié, Chief Engineer of La Sudure Autegene Francaise, Paris, France, is certainly one of the few, if not the only investigator, who has attempted to discover the cause of arc sputtering by direct experiment. He did not succeed, but a few remarks regarding his work are interesting as introductory. M. Brillié connected oscillographs with the arc circuit. He then placed a microphone fairly close to the arc so that the sound of the sputtering would clearly reach it, and connected another oscillograph in this microphone circuit. By comparing the charts, he found that the sound variations of the arc exactly synchronized with the electrical variations of the arc circuit. A number of apparently unrelated experiments will next be described and then the hypothesis will be developed from them.

Silent and Hissing Arcs

Experiments made many years ago, inspired by illuminating engineers, indicate the volt-ampere relation of the arc. Everyone knows that, as the voltage goes up, the current does down. It was found, however, that there was a sharp break in the curve representing this relation and at currents below the point of this break the arc is silent, while above it the arc hisses and is called the hissing arc. In the literature on the subject, no good reason seems to have been advanced. The solid line in Figure 1 shows the general form of the curve which these investigators worked out.

Chemical Changes in Deposit Metal

Nearly everyone familiar with metallic arc welding realizes that the electrode metal undergoes a change in passing across the arc. Those who have analyzed the deposit metal find oxides and nitrides present. This has been done in many laboratories, the Research Laboratory of the Chicago Steel & Wire Company having conducted an extensive series of experiments some years ago along this line. It was found that good commercial arc welds will contain 1% of oxides and nitrides while the carbon content will be less than that of the electrode.

Chemical Changes in Arc Atmosphere

Mr. L. J. Weber, of the Universtiy of Minnesota, has collected and analyzed the vapors dissipated by the metallic arc, and, among other things, believes he identifies the presence of an iron carbonyl. This chemical term may be better appreciated by the layman if he considers a carbonyl as a chemical compound made up of carbon monoxide and iron, for example. Weber's work not only accounts for where the carbon goes but also indicates that it is oxidized only to the monoxide rather than the dioxide and then combines with iron. In other words, only one atom of oxygen is required to carry away an atom of iron and an atom of carbon.

Arcs in Inert Cases

Work done by many investigators, first years ago and inspired by illuminating engineers, and more recently inspired by welding engineers, indicates that the voltage of the metallic

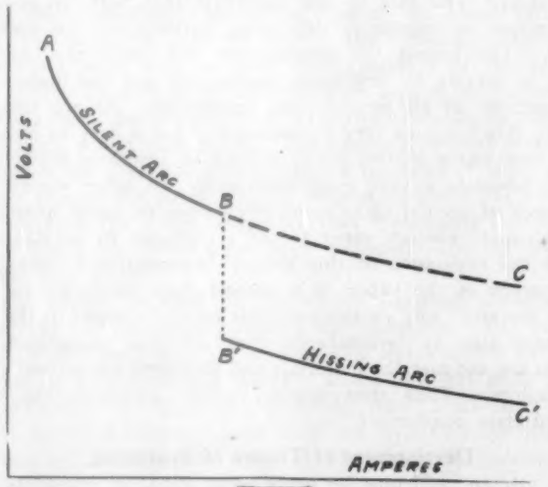


Figure 1

arc in an atmosphere of inert gas is much higher than in the air, a chemically active gas. Furthermore, the arc in the inert gas does not hiss, and the metal crosses the arc with little or no change. Probably on account of the publicity given the work of the General Electric Company's laboratories on the hydrogen arc, many interested in welding have purchased a cylinder of hydrogen to try it. The amateur experimenter has found that the moment he blows a stream of hydrogen on the arc it becomes very wild and seems to him to sputter badly. Many gases, and hydrogen in particular, diffuse rapidly into other gases and consequently, unless the stream of hydrogen is properly controlled, a thing almost impossible to do without special apparatus, what really reaches the arc is a mixture of gases varying all the way from pure hydrogen to pure air. This causes violent and instantaneous changes in the resistance as the mixture varies at different points surrounding the arc and as the arc seeks the path of least resistance, it jumps around in a very erratic manner. Few, if any, welding generators are regularly designed to take care of such radical changes in arc resistance and consequently they virtually add their disturbing influence.

Protective Electrode Coating

Extensive work has been carried on in the Research Laboratory of the Chicago Steel & Wire Company with Thorium Oxide coatings on ferrous metallic arc electrodes. After over a year's patient work, the materials and technique were developed for taking slow motion movies of this arc which clearly show the actual transfer of the metal, and they indicate what happens. Thorium oxide completely wets the surface of the molten drop as it forms on the end of the electrode and protects it into the arc vapors which themselves seem a perfect protection. The metal crosses the arc with little or no

*Research Department, Chicago Steel & Wire Company.

change but instead of the voltage rising, as is the case with atmospheres of inert gas, it falls sharply. In a spirit of friendliness to the amateur experimenter who may be tempted to try Thorium Oxide coatings on his electrodes, it might be well to say that this material costs not far from $50.00 per pound in the first place, and, without a very extensive knowledge of electrode design, the user will ruin more welds than he benefits with it.

First and Second Class Conductors

So much for the various unrelated experiments. No hypothesis is entitled to acceptance if it is not in accord with the well established laws of physics and chemistry. One of these applying to electrical conductors will be briefly reviewed. All materials from the standpoint of electrical conductivity may be divided into two groups. Materials are thus spoken of as "Conductors of the first class," and "Conductors of the second class." First class conductors are represented by the metals, while second class conductors are what are commonly called insulators. The fact of the matter is that both groups are conductors or insulators depending entirely on the temperature. The higher the temperature the lower the conductivity of metals, or first class conductors, and the higher the conductivity of all second class conductors. At arc temperatures, this becomes very pronounced and it is easy to imagine that iron vapor in the arc is almost an insulator while lime vapor becomes a very good conductor. In other words, the presence of second class conductors even in small quantities could supply enough vapor to the arc stream to substantially affect the resistance of this vapor. Apparently it takes not very much of the vapor of a second class conductor to saturate the arc. Any excess over this merely escapes in the air. It must also be remembered that chemical compounds of metals are not metallic materials and therefore are second class conductors. Thus iron nitride, oxide, carbonyl, etc., are second class conductors.

Development of Theory of Sputtering

An attempt will now be made to develop, by reasoning, an hypothesis which will explain or satisfy the various experimental data and at the same time be in harmony with the well known laws of physics and chemistry.

By referring again to Figure 1, it will be seen that the hissing arc exists along the volt-ampere range, as indicated by the solid line curve between points B′ and C′. All metallic arc welding, as it has been commercially practiced, falls entirely within this range, because the arc hisses or sputters.

The sharp drop in voltage between the points B and B′ must be accounted for, and, if this is done correctly, probably all other matters can be readily reconciled. A voltage drop strongly indicates a drop in resistance.

The introduction of a vapor of a second class conductor into the arc could explain this. As the arc current goes up the arc heat increases and it is conceivable that a certain critical point must be reached before the electrode materials, which are first class conductors, chemically combine with the materials of the surrounding atmosphere—air, of course, except under special conditions—thus producing second class conductors. Experimental data seems to be lacking regarding the presence of second class conductors in the silent arc, but the known changes in the electrode metal when it becomes weld metal show plainly that second class conductors are present in the hissing arc. The sharp drop in the curve is a critical point for some action and the fact that the silent metallic arc in air does not melt the electrode, taken with our knowledge of the hissing arc, strongly indicates that the critical point represents a change in the arc vapors from those essentially first class conductors to those essentially second class. A chemical reaction and a drop in arc resistance could very logically explain the whole situation. Chemical reactions, especially at elevated temperatures, are usually violent and this could account for the hissing, sputtering or crackling of the arc, as the case may be, characteristic of arcs between B′ and C′ on the curve. The exact action and resultant sound will depend on the nature and violence of the chemical reaction. The drop in arc vapor resistance would naturally drop the voltage required to overcome such lowered resistance and account for the sudden change from B to B′.

Suppose that the arc were maintained in an atmosphere of inert gas so that no chemical reaction such as is presumed to take place at B could occur. The curve A-B, instead of dropping sharply to B′ and continuing to C′, would logically be expected to continue on to C and the arc remain silent over the entire range. If the ordinary welding arc in air be transferred to an atmosphere of nothing but hydrogen, the voltage appears to rise and the arc become silent. Remembering that, for the commercial arc in the air, conditions fall between points B′ and C′, what really has happened in changing to a hydrogen atmosphere is to simply move up to the curve B-C.

Next consider the case of the electrode coated with Thorium Oxide. This prevents the chemical reaction with the air and hence silences the arc. Thorium Oxide itself is a second-class conductor and so tends to reduce the arc vapor resistance and thus lower the voltage. The volt-ampere curve for such an electrode should be a smooth line without a break from A or some point below it down to C′ or thereabouts.

The Theory of Arc Sputtering

Thus all of the unrelated experiments and laws of physics previously mentioned are reconciled and the hypothesis may be stated. The hissing or sputtering of the arc from an electrode represented by a conductor of the first class in an atmosphere which becomes chemically active with the electrode at elevated temperatures is due to a violent chemical raction between the two. This chemical reaction takes place at and above a certain critical temperature brought about by currents at and above a certain critical value. The resultant products of this reaction are second class conductors and their presence causes a drop in the arc voltage coincidentally with the change from silent to hissing arc as the current is increased.

Applications of the Theory

This theory will be found very useful to the engineer who must solve certain welding problems. The welding arc is itself the resultant of a complexity of electrical, thermal, chemical, and physical reactions. It is self evident that nothing so extremely complex can be brought under control by man unless he understands the fundamentals. This theory, along with the mathematics of penetration, the theory of arc heat distribution, and the like, are fundamental in nature. It is the starting point for bringing under control electrode deposit efficiency, accomplishing the transfer of metal across the arc without damage and the regulation of the flow of metal so that the welder can do his best work. The theory naturally is of more immediate interest to the electrode designer, but a knowledge of it can be used with profit by those who employ the metallic arc welding process. It will help them to avoid expecting the impossible and permit them to righteously demand a higher standard from the electrode manufacturer in such respects as improvement is consistent with fact.

DISCUSSION

By C. A. Adams

There is probably no group of phenomena in the whole field of engineering as complex and difficult to analyze as that involved in metallic-arc welding. It is perhaps on this account that so much of the research in this field has been of the superficial or cut-and-try variety, and so little of it aimed at a more thorough understanding of the phenomena involved. In any case, the result is that although we can make reliable arc welds within certain fields of application, we are constantly meeting unexpected obstacles when we attempt to extend the field or range. Even within the present range we occasionally stub our toes.

The trouble is that there is little fundamental or scientific understanding of the reason-why of arc welding. It takes not only courage but also a considerable knowledge of physics, chemistry and metallurgy in order to attack the problem intelligently. Even then we are almost completely lacking in information as to the behavior of the various compounds at the very high temperatures involved.

Any hypothesis which fits the known facts must be very serviceable, and may save an enormous amount of cut-and-try research. Hence, we all owe a deep debt of gratitude to Mr. Green for his hypothesis as to the sputtering of the arc, even though it may not be the last word on this subject.

Although I do not feel competent to pass judgment on this hypothesis, I would call to mind the fact that the behavior of conductors of the first and second class (to use Mr. Green's own language) at very high temperatures is as yet largely a matter of conjecture.

Before we can really get down to a reasonably thorough understanding of these phenomena, it will be necessary to carry out a comprehensive series of experiments of a very different kind from any as yet conducted in this field. The planning and conducting of these experiments should be in the hands of the highest type of scientist familiar with refined laboratory methods of measurement and with the very latest knowledge of physical and chemical phenomena.

It is on this account that the American Bureau of Welding is just organizing a committee with the purpose of conducting this type of research in the whole field of welding, and to coordinate all of the work that is now going on piecemeal in various laboratories. The kind of work to which I refer cannot be done in a comprehensive way in the laboratories of even our larger corporations, although some excellent work has been and is being done in these laboratories.

The difficulty with the present plan is that the workers in in any one laboratory usually are hunting for the solution of some immediate commercial problem, but have not the time to carry out such really scientific investigations as will lead to a better understanding of the phenomena involved.

I realize fully the objection that some corporations have to this kind of co-operative work, based upon a fear of some revolutionary discovery which, if made in their private laboratory, might constitute a large commercial asset. On the other hand, I can assure your readers, as the result of many years experience with the organization of co-operative research throughout the whole field of engineering, that the solution of this very complex problem is not at all likely to develop in any of our industrial laboratories, and that the return for money invested in co-operative research of this highly scientific or fundamental character is invariably greater than under the individualistic system where there is an enormous amount of duplication and waste effort.

I am quite unashamed at taking this opportunity to ride a hobby, as I am certain that it is for the good of the industry as a whole.

Finally, I wish to congratulate Mr. Green on what seems to be a distinct contribution to our understanding of arc welding, and to express the hope that he will keep up the good work.

DISCUSSION

By L. S. Weber

The paper presented by Mr. Green endeavors to propose a theory to explain the hissing or sputtering of the arc in the welding of steel. This theory as stated is that the hissing is due to the violent chemical reaction at the high temperature between the welding rod and the gases surrounding it. Due to the conductivity of the products formed in the reaction, the resistance in the arc is decreased with a consequent decrease in voltage.

The reactions in the arc are of a more complicated nature than intimated by Mr. Green. Besides the conductivity of the materials such as iron vapor and vapors of substances of second class conductors which would be very small, there also has to be taken into consideration the ionization that occurs when the arc is passed through a gas, as well as the ionization of metals when in the vaporized state. The work of the research department of the General Electric Company has shown that the hydrogen molecule is broken up into hydrogen ions. The liberation of electrons by metals and compounds such as CaO is made use of in the Coolidge and Wehnelt X-Ray tubes respectively. The formation of these electrons would have a great effect on the change in conductivity in the arc and may be greater than the conductivity of the vapors as suggested by Mr. Green. Even though the proposed theory may account for some of the actions of the arc, further consideration should be given to other reactions which may occur and have not been mentioned by Mr. Green.

In the discussion of the writer's paper, Mr. Green intimates that the carbon is oxidized only to the monoxide which then combines with iron to form iron carbonyl of the formula Fe (CO). It must be remembered that carbon monoxide has a great affinity for oxygen to form carbon dioxide so that both reactions would take place. The amounts formed would depend on the chemical affinity and on the laws of mass action. Even though the exact formula of iron carbonyl has not been determined, the writer suggested that it probably is $Fe(CO)_2$. Iron would very likely form larger molecules with carbon monoxide than Fe(CO).

The theory outlined by Mr. Green suggests a method of studying the protective covering for electrodes. Any material that would react with the surrounding gases would cause the electrode to sputter and therefor would not give good results in welding. Whether this would be true in all cases would have to be determined, and it is the writer's hope that Mr. Green will continue the study of this interesting subject.

HANDLING GAS ON PIPE LINE WORK

By J. H. Ady.

The transportation of acetylene and oxygen during the construction of pipe lines is an important operating problem and the methods of organizing for such work in the oil fields may prove useful to others who have welding operations which extend over a considerable area. We have an acetylene generator mounted on a heavy wagon which is stationed alongside the pipe line and parallel with it. The acetylene supply line is laid parallel to the pipe line and made long enough to enable the welders to weld all day without moving the generator. There is also a five cylinder oxygen manifold mounted on the same wagon, which is moved from place to place by the tractor, and a supply line running from the manifold alongside the acetylene supply line. We provided outlets in these lines by welding in some couplings or hose nipples and valves at intervals of 25 to 50 feet.

The generator and manifold are moved ahead at night and set up as far ahead of the completed pipe line as the gas supply lines will reach. All the welders have to do next morning is connect their hose to the nearest connection to the joint in the pipe line to be welded. Then he is ready to go to work. After the pipe has been welded up to the generator we work direct from the generator and manifold while the supply lines are being moved ahead and relay for another day's work. Practically no time has been lost by the welders. This organization of the work has proved to be a time and labor saver in pipe line construction.

There is a great volume of this work going on in the oil fields where large storage tanks are going up every day and pipe lines are being welded and laid to convey the oil to them. Good pipe welders are in demand all the time at good wages. In fact the wages are so high that it is necessary to plan the work with extreme care so that time is not wasted.

English Welding Practice

Publicity Methods Have Gained Wider Adoption of Welding in America Than in England—Applications of Processes Compared

By P. L. Roberts*

AMERICAN readers may sometimes wonder how far welding has progressed in England. It is intended, therefore, in this article to give a brief general idea of the state of that industry. The best way to do this is to contrast it with American practice. This will assist direct comparison, and give the reader a fuller appreciation of the facts.

Undoubtedly, welding is more extensively used in U. S. A. This is due to two reasons: the first being that greater publicity is given to welding (as in all things), and the second is that engineers and the public are less conservative. Amongst those actually concerned in welding, there is probably as much known about the subject in England as in America, and it is not due to this that differences do occur in the two practices, but to other influences. The chief of these is the conditions imposed on the welding firms by their customers. Other influences are, specialized interests in the welding trade itself, working conditions, and labor.

Unlike American practice, the metallic arc is used much more extensively than the oxy-acetylene flame, always on the score of greater economy. The resistance processes have not been adopted to the same extent to the manufacture of the more complicated repetition products.

To simplify comparison, each welding process will be dealt with under a separate heading, and under two sections, similar and dissimilar applications.

The Carbon Arc

The carbon arc is used for welding large blowholes in steel castings. Unless care is taken, carbon is absorbed by the weld with the increased difficulty of machining afterwards. Great difficulty is experienced in obtaining operators for this process who are thoroughly capable of producing a weld in mild steel which is the equal of a metallic arc, or oxy-acetylene weld in the same material. This naturally limits the application of the process.

Copper is welded with the carbon arc and satisfactory results obtained.

The Metallic Arc

There is one great difference in the respective practices of the two countries in metallic arc welding, and that is in the type of electrode used. Whereas it is almost universal practice in America to use a bare electrode, in England practically nothing but fluxed electrodes are used. Here America scores heavily on a point of economy. There is recently, however, a strong tendency to change in both cases. English welding firms are being forced to use a cheaper electrode through pressure of competition, and so the dipped is steadily replacing the covered electrode. The dipped electrode is similarly finding greater favor in America. The reason for the wide divergency of practice, which is now tending to become less, was initially due to strong manufacturing interests in covered electrodes. Welding in England grew with the covered electrode, then later tradition and the conservative element in welders fostered their continued use. In America welders used the cheapest thing—the bare electrode—because they knew no other, and becoming expert in the manipulation had no desire or reason to change. Now, when greater penetration and easier manipulation is required, a lightly fluxed electrode is used.

As regards the plant used, there is not a great deal of difference. The reverse compound winding is the basis of design of nearly all English arc welding generators. This type of generator is undoubtedly the most efficient and simplest to operate, consequently it is rather surprising that it is not more generally used in America.

Automatic arc welding originated and is being well developed in the States, but in England there is only one type of plant being manufactured, and this has practically little application yet. This again is due to the fact that mass production methods are not nearly so readily applicable in England.

The Oxy-Acetylene Flame

Dissolved acetylene is very much more widely used in U. S. A. than England. This is due to its being cheaper and the greater use for readily portable supplies of acetylene.

There is no essential difference in the blow pipes (or more familiarly "torches"). Details vary, however, and here America has made an important advance in standardizing connecting nipples.

Resistance, Butt and Spot

Although the process of resistance welding is of great importance in the cheap manufacture of thousands of small articles not nearly so much is heard of it in either country as the previously mentioned processes of welding. Plants for dealing with much heavier sections have been developed in America, but the application of the process in general appears to be wider in England.

Other Forms of Welding

Thermit welding in both countries is principally applied to the welding of rails and large sections of a similar type. Very large repairs are also effected economically.

In the States percussion welding is used to some extent, but not in England. A process which largely takes its place is used, known as the Cyc-arc process. Whereas percussion welding is used for jointing small sections (or one small section to a larger), such as wire, the Cyc-arc process is used for welding heavier sections, such as studs to bulkheads.

APPLICATIONS

Points of Similarity

The application of welding to the manufacture of such products as tanks, pressure vessels, of all sizes and for all purposes, is general practice in both countries. The metallic arc in both cases is most generally used on work thicker than ⅛ inch.

Cast steel repairs are extensive and are generally effected by means of the metallic arc. Such recovery work, often of necessity being made after machining of the casting, has to be welded with the metallic arc to reduce the possibility of distortion to a minimum. The resulting weld is harder than the rest of the casting, so, though not widely known, a process of locally annealing with an oxy-acetylene flame is used in England to overcome this trouble.

The welding of cast iron is accomplished with equal success

*Engineer, Metropolitan—Vickers Electrical Co., Ltd., Manchester, England.

in both England and America. The metallic arc and the oxy-acetylene processes both have their spheres in this class of welding. Most of the "dodges," such as studding, local pre-heating, etc., seem to be generally known. There is one little trick where the English have the advantage, and that is in the use of "gap" preparation, which greatly assists in the successful application of the arc.

Recently America has rather "raced" England in the construction or partial construction of the steel framework of buildings, by means of welding. England has only attained to the garage and small workshop type of welded building so far, but the joints and methods used are similar.

Points of Difference

Pipe line welding is practically unknown in England, and this is largely due to the fact that there is no demand for miles of cheap pipe line, there being no oil wells.

Gas holders have not yet been made by welding, because gas engineers know nothing about welding or its advantages. This also accounts for the reason welding has not been applied to gas mains.

In shipbuilding, arc welding has been widely applied in England. The main difficulty in applying it to the actual shell plates has been one of labor. Though arc welding has been used for jointing shell plates, serious trouble with trade unions has prevented its extended use. The process has been applied to almost all other jointing work on ships. One very important application is the welding of Z shaped clamps to the ship's decking. There are thousands of these used in the latest types of ships, and they serve to anchor the flooring cement which is afterwards laid on all covered decks. Anchors are also made up by welding the shaft onto the base plate, and the grappling plates onto the arms.

English locomotive frames being made from rolled sections, rarely, if ever, fracture as do the American solid type, so welding on this class of work is unknown.

Monel metal is not used to any extent, as in America where kettles and similar domestic utensils are made from it. For this reason the welding of this metal though made an experimental success, has not been developed commercially.

Welding is being applied in England to the construction of steel houses, which is likely to prove a very large undertaking.

Though the ordinary methods of publicity are not used very extensively in England to make welding known, much useful propaganda work is being done in other ways. The comparatively newly formed Institution of Welding Engineers is doing good work in banding together all welding engineers, and in the reading and publishing of papers, etc. There are also about eight oxy-acetylene welding schools, formed in connection with technical colleges. The first metallic arc welding classes in England are shortly to be commenced and conducted by the writer in the Manchester College of Technology. In this and many other ways welding is becoming known as an indispensable and reliable process. Combined with this is a rapid growth of technical knowledge of the process amongst those intimately concerned. By such means welding is becoming one of the most important branches of engineering.

THIRTEENTH MID-WINTER MEETING OF GAS PRODUCTS ASSOCIATION

The thirteenth Mid-Winter Meeting of the Gas Products Association will be held at the Sherman Hotel, Chicago, January 20th, 21st and 22nd.

A good strong program is being prepared, in fact it is just about completed. In this program will be found many items of interest, which should be of constructive good for every member of the Association.

Mr. W. L. Churchill has agreed to be present on the afternoon of the first day and lead in a discussion of plant costs and pricing.

On the second day there will be a great many items of interest to present, regarding the various uses which are being made of oxygen, some of which in all probability will be new, and may be of assistance in helping to find new markets.

Saturday, the last day of the Convention will be given over to discussion of operating problems and also safety measures.

Thursday night will be a free night for Members to get together and become better acquainted in any manner which they may decide best suited to their individual requirements.

Friday night there will be a Theater Party at the Apollo Theater. The show is the "Great Temptations" and is ranked as one of the best if not the best spectacular review which has been in Chicago this season.

Saturday night will be the regular banquet and entertainment. This banquet is taking on the nature of an informal dinner with entertainment. There will be less speech-making than ever before, but more good entertainment and even more good fellowship. The program which has been arranged for the evening promises to be exceptionally attractive.

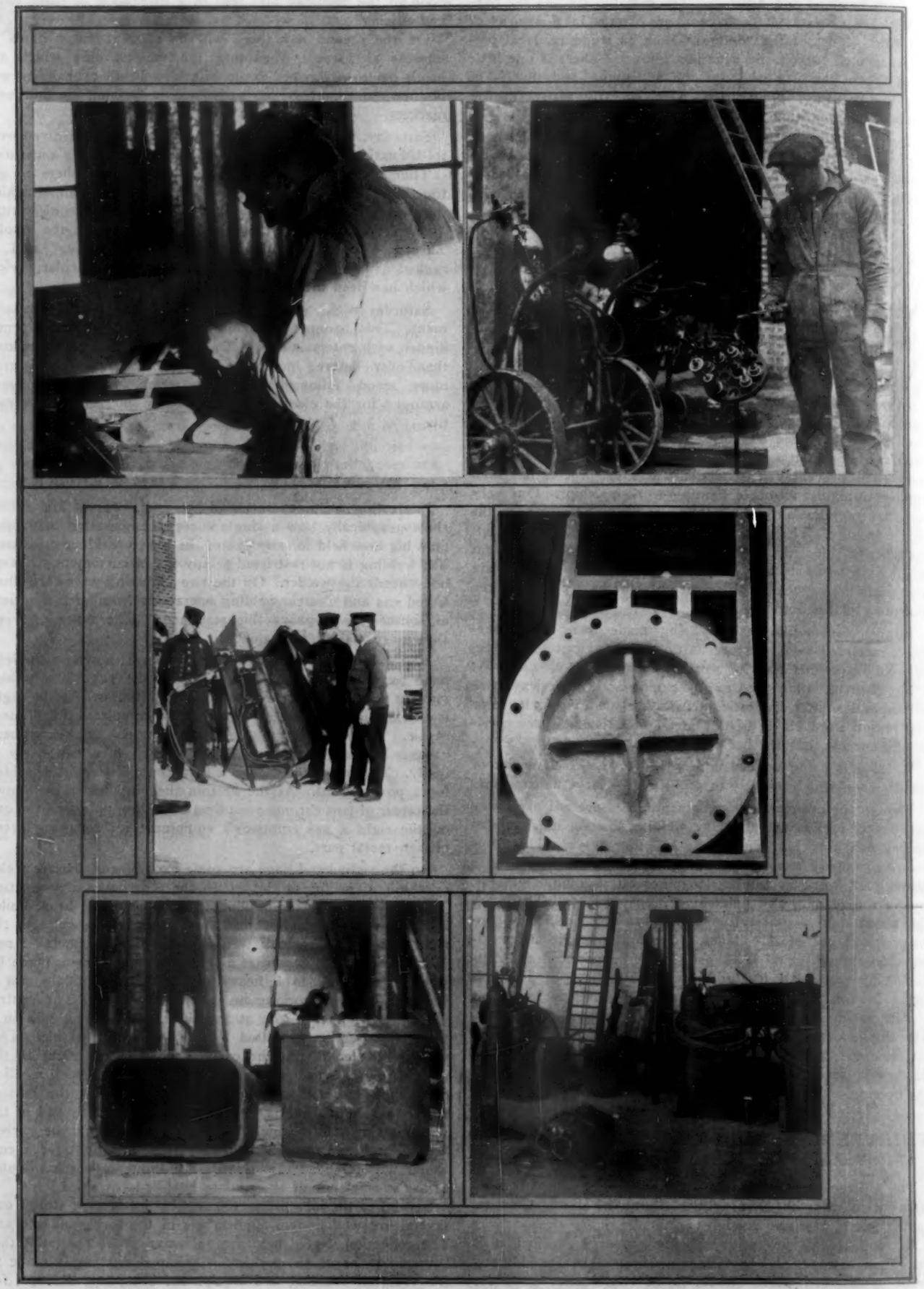
EVERYBODY NEEDS THE WELDER

Interesting welding stories of the past, present and future show graphically how a single successful operation may open up a big new field for any one of the fusion welding processes. Yet welding is not restricted to any list of customers. Everybody needs the welder. On the two following pages are illustrated gas and electric welding operations from such a variety of sources as to prove this statement. The types of work shown are both old and new.

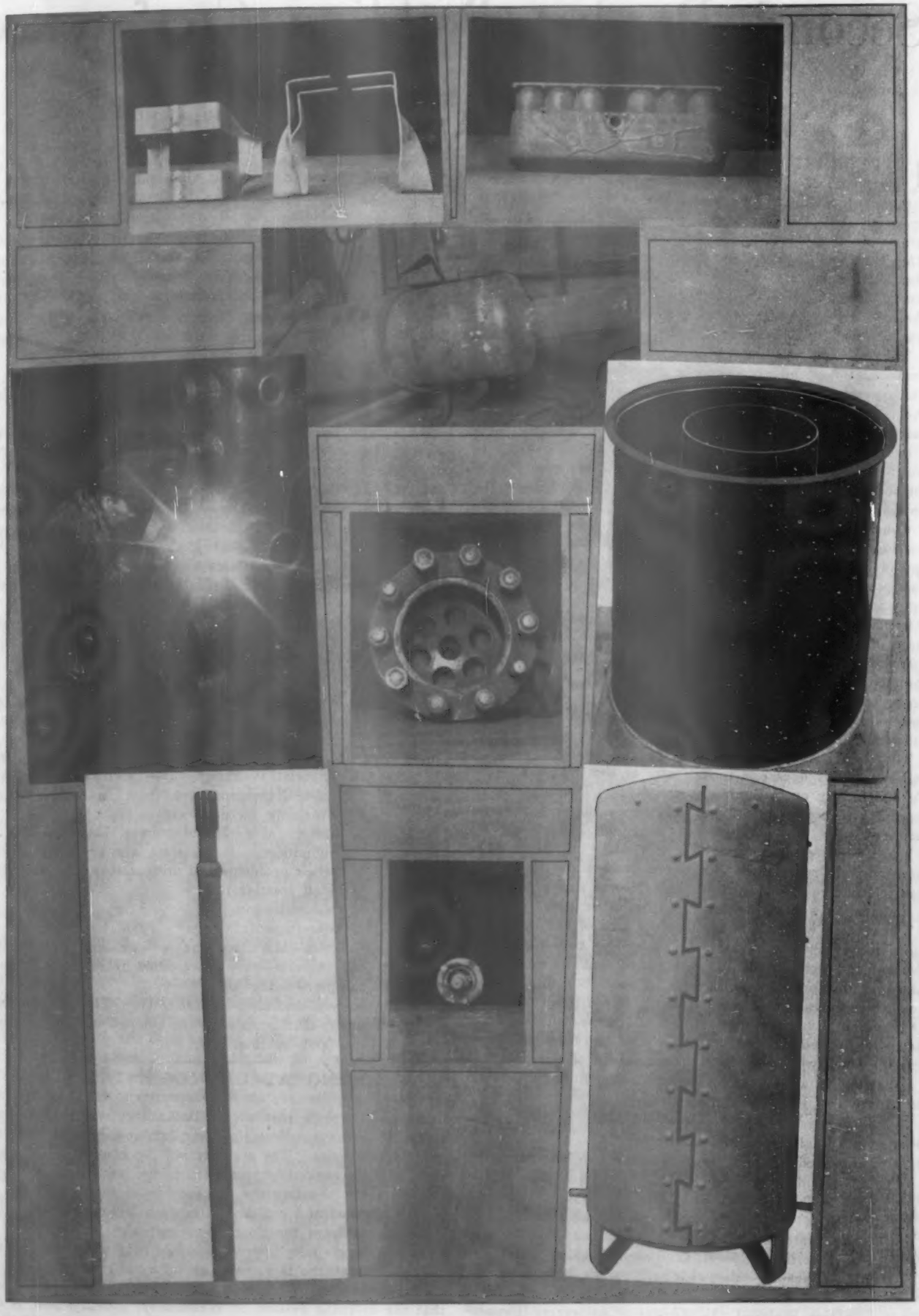
Half a dozen oxy-acetylene operations are shown on the left-hand page. At the left on the top of the page is a welder making props in the Educational Film Studios. At the right is an experienced operator who has just completed a drill stem repair. The left center photo shows how one fire department mounts a portable cutting outfit so two men can carry it easily. To the right of this is a cast iron cylinder head welded for a power plant. At the bottom the left illustration shows the repair of two chrome vanadium annealing pots, and the one on the right a gas company's equipment for repairing every broken metal part.

On the right hand page are some examples of the arc welder's skill. The job at the left in the top row is a production job. Steel stirrups for holding wooden beams in brick buildings are made by assembling two pieces as shown. At the right is a cylinder block welded cold with the metallic arc. Just below, in the center, is a large annealing drum, made by welding the tank to a heavy shaft. In the middle row a welder is shown working on a large manifold. The central picture is of a cast iron steam chest. The break was in a three inch section indicated by the white area inside. This was welded cold with the carbon arc. At the right in the middle row is a special tank, a type of job in which welding often makes the impossible design possible. In the bottom row is a rebuilt armature shaft shown at the left, and in the center an armature which has been welded with the carbon arc. The lower right hand corner is a tank built for a customer who intended that this design should offset his doubts as to the efficiency of an ordinary butt or lap welded joint.

Several of the jobs illustrated suggest interesting stories and several are well known applications of the torch and the arc. The collection should help any salesman prove the point that "everybody needs the welder." Acknowledgment is made to the Western Welding and Equipment Company, Chicago, for their courtesy in furnishing many of the illustrations in these two groups.



Everybody Needs the Welder (See page 33)



Everybody Needs the Welder (See page 38)

Second Purdue Welding Conference

Industrial Plants of Indiana Treated to New Program of Papers, Discussions and Demonstrations of Latest Developments

IN DECEMBER, 1925, the Engineering Extension Department of Purdue University held a two-day conference on welding, for the benefit of representatives sent by industrial plants from all parts of Indiana. The program of that first conference was described in detail in *The Welding Engineer* and it is was predicted at that time that such a program could not fail to prove valuable to the welding industry. The University officials were pleased with the response received by the first conference and a second one was planned for December 15-16-17 of 1926.

The program was not far under way until it became evident that the attendance would be even larger than in the previous year, and that the interest was just as keen as before. As a matter of fact it is seldom that meetings of this sort are marked by such a degree of sustained interest and attention. Undoubtedly, considerable credit for this is due to the splendid work of Professors W. A. Knapp and J. D. Hoffman of Purdue University in arranging the program of papers and demonstrations.

Considerable time during the conference was spent on discussion of what were really new processes and new subjects and in connection with some of the old subjects the speakers had prepared material which would present them in a new light and furnish a considerable volume of new and useable information. Descriptions of new products and new methods were presented in such a way as to keep the flavor of commercialism noticeably subdued. The audience of welders, foremen, superintendents, department heads and engineers kept their seats as long as the speakers were willing to talk and followed up all sessions with group consultations which showed a definite desire to learn more.

The total registration at this conference was two hundred and ten. This does not include any of the members of the Purdue faculty or the university students. These young engineers attended practically all of the sessions in generous numbers.

Twenty-five equipment and supply firms in the welding industry were represented in this registration and seventy industrial concerns from thirty-three differents towns and cities in Indiana, as well as twelve firms from other states.

The opinion was unanimous that the men of the University had done everything possible to make this conference both pleasant and worth while. It is expected that the success obtained in this program will result in the establishment of a welding conference as an annual event in the program of the Engineering Extension Department. It is not difficult for men who are working in the industry to appreciate the direct benefits which will result from a continuance of this program.

Following is a list of the papers and demonstrations on the program of the 1926 conference:

Wednesday, December 15th

10:00 a. m. Registration and Inspection Trip.

1:30 p. m. Welding and Its Application to Manufacturing (illustrated)—W. M. B. Brady, Welding Specialist General Electric Company.

The Welded Joint in Structural Work (illustrated).

Electric Weld—A. G. Bissell, Welding Engineer, Westinghouse Electric and Manufacturing Company.

Gas Weld—T. W. Greene, Engineering Department, Linde Products Company.

Exhibits and Demonstrations.

7:00 a. m. Thermit Welding (illustrated lecture and demonstrations)—J. H. Deppeler, Chief Engineer, Metal Thermit Corporation.

Rail Welding, Bonding and Other Welding Problems (illustrated)—Karl Haas, Welding Engineer, Una Welding and Bonding Company.

Thursday, December 16th

8:00 a. m. The Welded Structural Shape as a Substitute for Gray Iron Casting—R. E. Kinkead, Engineer, Lincoln Electric Company.

What We Know About the Welded Joint—E. E. Thum, Publicity Department, Oxweld Acetylene Company.

The Welded Joint as Seen Through the Microscope (illustrated)—H. L. Maxwell, Asst, Professer, School of Chemical Engineering.

Discussion.

1:00 p. m. Bronze Welding—W. C. Swift, American Brass Company.

Welding Rods—J. J. Crowe, Research Dept., Air Reduction Sales Company.

Stelliting Metal Parts—R. L. Lerch, Engineer, Haynes Stellite Company.

Some Ways of Improving the Welded Joint—H. S. Card, Editor, Welding Engineer.

Exhibits and Demonstrations.

6:30 p. m. Informal dinner.

Illustrated Talk, Engineer in South America—J. L. Bray, School of Chemical Engineering.

Friday, December 17th

8:00 a. m. Round Table—Welding on Repair Work and Special Welding Jobs—Electricity, Gas Thermit—Representatives from Manufacturers of Welding Departments.

Round Table—Manufacturers' Problems. (Manufacturers of the state are urged to outline their problems and present them for discussion and solution.)

Demonstration.

12:00 M. Adjournment.

Note: Exhibits—Manufacturers of welding equipment—Electric, Gas, Thermit—were represented by exhibits of equipment and sample welding jobs.

Demonstrations included—Electric, Gas, Thermit welding; bronze welding; aluminum welding; Unafied welding; cutting; oxygen lance; spot welding, etc.

WELDING AT CARNEGIE INSTITUTE

On January 18, 19, 20 the Department of Industrial Relations of Carnegie Institute of Technology will hold its third annual three-day institute for the plumbing, heating and ventilating industries. The sessions will be conducted by chairmen who are nationally prominent in the industries. Lectures will be given showing the relationship of these industries to human comfort and health. After each lecture and following a discussion from the floor an opportunity will be given to those who are vitally interested in the subject to continue the discussion with the lecturer at an informal round table.

It is interesting to readers of *The Welding Engineer* to note that the morning session of Wednesday, January 19th, is devoted entirely to welding. The first paper, entitled "Welding

in the Plumbing and Heating Industry," is by S. E. Dibble. This lecture will discuss the adaptability of the welding torch in making joinings where black iron and steel piping are used. It will also illustrate and demonstrate the making of branch joints by the welding process, the joints then being tested for strength. During this lecture a complete welded steam heating job fully erected will be discussed and can be seen in the plumbing and heating department. The second paper, entitled "The Welding Process" is by Prof. R. B. Leighou. The discussion will dwell on the gases used in welding, the chemical action which takes place in metals when they are fused and the ways of recognizing a poorly fused joint. The lecture will also include the theory of the entire welding process.

This announcement will indicate that the subject of welding will get a very favorable introduction to the plumbing, heating and ventilating industries. It is going to be worth while to get in touch with these industries and follow up in some measure the good work done in Pittsburgh so that there will be no opportunity lost to develop whatever new interest may be aroused.

A WELDING MEETING AT NORTH TEXAS AGRICULTURAL COLLEGE

Announcement has been received that a "get-together meeting" of welders and those interested in welding will be held at the North Texas Agricultural College, Arlington, Texas, on March 4th. The complete program has not yet been prepared but the plan is to make it as broad as possible in scope. It is hoped that this meeting will become a yearly affair and will be recognized as a real benefit to the industry in that locality.

OVERCOMING WELDING DIFFICULTIES

By M. D. Goodman*

THE following is a list of experiences in actual arc welding. In each case it illustrates how a difficulty was successfully overcome.

In a steel castings plant some of the castings would present a good appearance but when they were put on a boring mill or other machine to be turned to size, blow holes would appear on the inside of the casting. After the casting had been set up in the machine the only practical thing to do was to fill up the holes by welding while the casting was in the machine.

The machine shop was quite a distance from the welding generators. These were of the multiple operator type. In order to save one line of cable, one terminal of the welding generator was effectively grounded and each machine tool was also properly grounded. This made it necessary for the welder to run only one instead of two long cables to the machine tool on which the casting to be welded was placed.

Resistance Solves Sheet Metal Problem

A small welding shop had a 200 ampere variable voltage arc welder and occasionally had need for welding very thin sheet steel. This welding machine would permit him to draw current as low as 50 amperes, but this current would burn through the sheet steel. A set of resistance of the proper value was inserted in the welding circuit and then the rheostat of the welder was properly adjusted. This permitted welding on 30 amperes and in this way the very thin sheet steel was successfully arc welded.

When the Power Voltage Varies

A welding shop bought a 220 volt, 3 phase, 60 cycle, motor-driven welder. He used it in his shop and occasionally took it out on a job where the customer had electric power. However, sometimes the customer used 440 volts instead of 220. At a very small expense the motor was arranged for 220 and 440 volts. The motor leads were brought out to a terminal board and by changing a few connections on this terminal will.

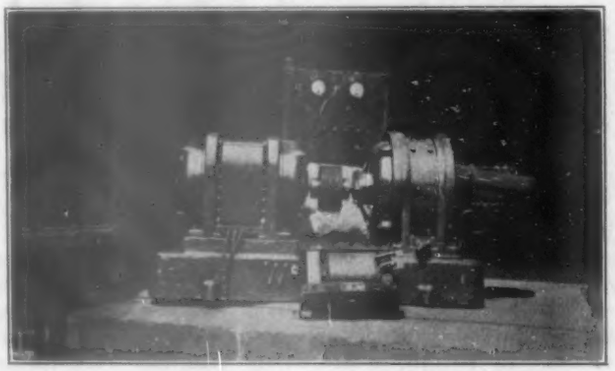
*President, Goodman Electric Machinery Co., Newark, N. J.

board the motor could be changed from 220 to 440 volts at

The writer has seen one electric motor-driven welding outfit in which by means of a small switchboard on the motor the latter was conveniently arranged for either 2 or 3 phase, 220 or 440 volt. This arrangement did not give him perfect motor connections on both 2 and 3 phase—but—it permitted him to do the jobs satisfactorily, and this is what he was after.

New Control Saves Old Machine from Junk Pile

A good sized welding shop was using a constant potential welder of the type that uses the carbon pile control. This equipment was six or seven years old. The machine itself was good but the control was not very good and the company was going to junk this outfit. Our engineer made a test on this



New Control Kept this Welder on the Job

machine and found that if the control panel was replaced with properly designed control that this machine was as good as any modern outfit. Photograph shows how the machine looked with the new control.

A small welding shop that had been doing oxy-acetylene work happened to come in possession of some second hand storage batteries. This welding shop owner asked us if it is possible to use this to do any electric welding. The batteries were in good shape and had ample capacity. We showed the welder what connections to make to get the proper voltage and then designed a proper kind of control and stabilizer for him. This outfit was used with success. It is of course not recommended for anyone who does very much electric welding, but for an occasional welding job it is entirely satisfactory.

When Long Leads Were Needed

A job welding shop was using a motor generator. This welder took a job that necessitated very long leads. The man on the job had practically given up hope of making this machine work with these long leads. As a last resort he called us on the long distance telephone and asked for help. When we arrived at the job we took a heavy bar of copper and placed it in parallel with the divertor resistance grids. This completely shunted out the differential compound field on the welding generator and sufficient current and voltage were obtained to do the job.

It is possible that the reader may desire further details on any of the methods mentioned in this article. The writer of this article will gladly give further details to any one asking for them.

ADVERTISING SLIDES FOR JOB WELDERS

A set of lantern slides advertising the value of oxy-acetylene welding as a repair process has been prepared by the Smith Welding Equipment Corporation, Minneapolis. Each slide is in four colors, carries a picture, preaches the doctrine of "Have It Welded" and shows the name of the user in prominent letters. Single slides or the complete assortment can be obtained, imprinted as desired, at low cost, all ready to be shown in the local theatre.

Testing Gas Welds*

A Review of Present Testing Methods With Suggestions for Testing Devices and Further Research in Welding Problems

By H. L. Whittemore†

THE oxy-acetylene torch was one of the first pieces of apparatus used for commercial welding and its success, undoubtedly, led to the rapid increase in the substitution of welding for other methods of fabrication.

The extensive use of oxygen for cutting ferrous metals using apparatus and technique similar to those used for gas welding makes it almost inevitable that cutting and welding should work together, on many jobs. The simplicity of this gas apparatus, and the ease with which it can be used, make it particularly adapted for frontier conditions, whether on construction work in rough or unsettled country, with the wrecking crew on the railroad, or where the guns are booming in a war.

Under more settled conditions but where there is great competition gas welding is widely used particularly for thin and for non-ferrous metals. Many steam pipe lines where the pressure and temperature are unusually high are gas welded. In aircraft, where safety rightfully receives first consideration, the tubular steel fuselages are gas welded almost exclusively. Commander Byrd flew to the pole last summer in a Fokker Airplane. The Fokker Company claim that the fuselage of steel tube having welded joints has now become standard practice and its advantages are universally recognized, both on the score of *safety* and *economy* of *maintenance*. They list the outstanding advantages of fuselages fabricated from steel tubing thus:

Maximum resistance to collapse in a crash,

Minimum damage,

Minimum expense for repairs; with a hack-saw, a hammer, a portable welding outfit and some tubing even the most extensive repairs can be made permanently, anywhere, with a minimum of stripping,

and explain that "the allegation usually made is that repairs are difficult and require specially trained men who are not available everywhere. The actual fact is, of course, that any mechanic can in a few hours be taught to weld sufficiently well to make permanent, quick, and clean repairs in these fuselages, with a minimum of equipment and material."

Workmanship—One of the important problems in commercial welding is to obtain good welds with certainty. This involves not only good workmanship but good judgment. Most of us can point to welds which should never have been made. Any failure of welded structures leads to an undue restriction of all welding, both good and bad. The apparent ease with which the technique of welding can be learned and the paying of welders on a piece work basis have not always resulted in workmanship which is a credit to the industry. Undoubtedly the quality of work would be greatly improved if conscientious and competent inspectors were in charge of the fabrication.

I believe there is need for detailed instructions, illustrated by photographic prints of good and bad welds, which will assist inspectors in their work. This information is now possessed by many men in the industry but is not distributed so widely that it is common knowledge.

The design of the welded details is often left to welders who have had only limited experience. If simple, direct instructions in shop language, well illustrated, were in the hands of every welder the quality of the work could be greatly improved. The manipulation of the torch and the technique employed by each welder should be carefully supervised, and if he is not doing his work in the best way he should receive training.

Courses in welding seem to be a necessity. As you know, the Portland Cement Association has just completed a course on how to use cement. Their problem, to prevent the improper use, due to ignorance, of a good material, is much like the one which confronts us in welding. They are succeeding in their efforts to educate the users of cement to the point, that, when a concrete structure fails the responsibility rests upon the engineer who did the job, not on the cement manufacturer.

Welding schools already have been successfully carried out on large jobs. A striking example is the school established by the Linde Air Products Company in connection with the installation of some 200 miles of pipe line in the Southwest. Welded joints were used throughout this job and most of the welding was done by hired men locally who had never held a torch before they reported at the school. Working under the constant supervision of experienced, intelligent welders, some of these men were able to complete their training in a few weeks and were ready for the line. Others failed to qualify, and were sent back to the job as laborers. Each joint on the line as it was made was marked with the welder's number so that responsibility could be readily fixed for the failure of any joint. The interest and sense of responsibility developed in the school paid gratifying returns on the job.

Responsibility for the development of improved processes and for welds which give satisfactory service must be assumed by the welding industry under competitive conditions; any other policy is suicidal. Research is the only doorway which opens on the pathway of success, technical and financial. The cost of research work is now recognized as necessary and it is budgeted with taxes, insurance and depreciation.

Some philosopher has explained that life consists, fundamentally of constant change. If even for a second no change occurs we are dead. Who can doubt that this theory holds for manufacturing organizations. There is one way to improve welding apparatus and methods and that is the careful investigation of welding problems by a skilled staff.

There is no more effective weapon in competition than the fact that an industry is constantly improving its product.

"The "Nation's Business" representing the U. S. Chamber of Commerce, preaches that undesirable practices must be eliminated by the industry before legislative bodies pass laws to correct the evil. Where the trouble is a technical one and lies in ignorance of how the evil may be corrected the fact that the industry is, in good faith, seeking a solution by research methods will often prevent premature legislation.

Tests for Workmanship:—While we wait, not without some impatience, for a non-destructive test for welds which is commercially practicable we must content ourselves with the usual tensile and other laboratory tests. For a rough check on the quality of a weld the cold bend test has proved valuable. I hope to see most welding shops use some simple testing

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*Paper presented at International Acetylene Association Meeting, Chicago, Nov. 11, 1926.

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†Bureau of Standards, Washington, D. C.

machine which gives numerical results. The Charpy impact machine meets this need very nicely. Leave off all gadgets and superfluous money-consuming refinements. Provide an anvil to support the specimen, uprights of any suitable rolled steel section, a pendulum of one inch steel bar four inches wide swung on an axle at the top. To make a test, swing the pendulum up until it rests against a stop just beyond the top center. Drop the specimen into place in the anvil. Push the pendulum over the center. Crack! goes the specimen. Record the energy, absorbed by a specimen, by a maximum pointer on a graduated dial on the axle. Nothing could be simpler or less expensive.

The specimens might be half inch square, about three inches long with the weld at the middle. Any shop man could make them with a hack-saw and bastard file if machine tools are not at hand. There would be no need of notching them as the ductility of most welds is so low that the specimens are sure to break.

Could a machine of this kind not be made for one hundred dollars and be used daily? If a welder does not care to buy one of these impact machines, let him build one; the material he can easily obtain.

Before the results of impact tests are accepted as a measure of the quality of a weld, a careful comparison should be made between impact and other tests. I am convinced that if this is done that in expensive impact tests will give us a "yard-stick" by which we can measure workmanship. Having this the problem of the poor weld is half solved.

An impact test would show up poor fusion at the bottom of a single vee weld better than a tensile test if the bottom of the vee were on the tensile side of the impact specimen. In any event, the weld metal would be subjected to higher stresses than the base metal which is not the case in the tensile test.

I believe that it is practically impossible to make a weld having the strength with high ductility. Starting then with a poor weld we would get a low impact value. Better welds having higher strength would give higher impact values. Further improvement would not increase the strength appreciably but would increase the ductility and this would approximately increase the impact value in the same proportion. It seems likely that the impact test would be a sensitive test for the ductility of the weld which is not easily measured by a tensile test. Since writing this paper, I have read Nenetrier's article[1] which indicates that the impact test has great possibilities.

The great disadvantage of specimens made expressly for test is that they do not necessarily represent the regular output of the welder. Although impact specimens can be cut from a structure such as a tank and the structure repaired for service this is not practicable in most cases. Whether or not specimens for test truly represent the work the welder is doing depends largely upon the moral qualities of the welder. **Welding for the best results requires workmen who realize the responsibilities placed upon them and who consistently refuse to do work which they know is unsatisfactory. We should do all we can to create this spirit of craftsmanship and take off our hats to welders who have it.**

Research

Laboratory Tests for Welds:—The methods at present in use for measuring the physical and metallurgical properties of metals seem to be entirely satisfactory for the examination and testing of welds. Too often only the ultimate strength of a weld is determined when the proportional limit is of equal importance. The small amount of weld metal in the joint makes it difficult to measure the elastic properties of the weld itself. It seems to me that much valuable information could be obtained quite easily by building up specimens entirely of weld metal.

1. Journal American Welding Society, January, 1924, p. 13—"A Cheap Reliable and Exhaustive Method of Testing Welded Joints."

When investigating the behavior of welded structures under load the hand strain-gage should be more generally used. Using this instrument, structures either in the laboratory or in the field can be examined in great detail, readings being taken on a hundred or more gage lines if desired. Even if no claim for high precision can be made for the stresses determined in this way, regions of high stress become apparent and the data provide a basis for changes in the design or in the method of welding which does not exist when the ultimate strength only is determined. Examination of a structure which has failed under load seldom shows where the stress becomes excessive. Examination of the shell of an exploded boiler which sailed through the roof of the boiler house and landed, much distorted, several hundred feet away, will, I think, convince anyone that this statement is, in general true.

One objection to welding which does not apply to other methods of fabrication is that the process causes initial stresses in the structure, the magnitude of which are unknown. The strain-gage can be used to measure these stresses if measurements are taken on the same gage lines both before and after the structure is welded. The best method of reassuring those who fear fabrication stresses in welds is to measure them.

Non-destructive Tests for Welds:—This subject has received much consideration in the past. It presents great difficulties and the best scientific and technical ability is needed if the problem is to be solved satisfactorily.

Of the tests which have been proposed, the following are three:

1. The Electrical Resistance Method:—The electrical resistance across a weld can be accurately measured even when the weld is part of a structure, such as a steel ship. The difficulty is not in measuring the resistance but in finding a relation between the resistance and the strength of the weld. Clean metallic surfaces which are in intimate contact have low electrical resistance but no tensile strength. This method does not seem to offer a solution of our problem.

2. Magnetic Analysis:—Measurements of the magnetic flux in ferrous metals under a constant magnetizing force has all the requisities except one for a non-destructive test of welds. It is inexpensive, rapid, and can be used almost anywhere. The one exception which is most important is that it does not infallibly indicate defects which affect the strength of the joint. However, it errs on the safe side. This method is now being used successfully to locate defects in steam turbine bucket wheel forgings. It is difficult however, to see how this method can be used on welds where the thickness and contour of the metal varies greatly, such for example, on the fillet weld where an I-beam joins a column. The magnetic method is particularly suited to long pieces having a uniform cross-section.

Some experts in this field believe that magnetic analysis will eventually be successfully used to determine the quality of the welds, but we must remember that the magnetic permeability of the material depends greatly upon the stress and still more upon the heat treatment to which it has been subjected. Most metals have had a reasonably uniform heat treatment so that this very disturbing influence does not make the detection of flaws impossible. When, however, it is used on unannealed welds the variations in permeability caused by the welding process effectively mask the defects in the welds. If the welds are annealed after fabrication some defects become apparent.

3. X-Ray Examinations:—The work which has been done on this method seems to show that many defects in welds can be detected but the defects must be cavities in the metal either filled with gas or non-metallic inclusions or must be cracks or other discontinuities which are approximately parallel to the direction of the rays. The indications fortunately are not affected by the stress in the material nor by varia-

tions in the heat treatment. At present, it seems evident that more work should be done to perfect this method, as it is not affected by conditions which are unavoidable in welds. We may, therefore, expect within a few years that X-Ray examinations will be made, commercially on important welds if the thickness does not exceed two or three inches. The cost, however, is high at present, five or ten dollars for each photographic record.

Effect of Variations in Technique:—So far as I know there has never been a careful study of the effect on the properties of the weld, of variations in torch manipulation which occur in practice. For example:

(1) For a given ratio of acetylene to oxygen what is the strength of the weld? Is there an appreciable range for this gas ratio over which the properties of the weld are not appreciably affected or must the theoretical ratio be accurately maintained?

(2) What is the effect of varying the distance of the torch tip from the weld? Does this affect the optimum gas ratio?

(3) What effect has the angle of the torch tip to the work? It has been suggested that if the torch was held perpendicular to the work all the heated metal would be bathed in the gases from the torch until the temperature was so low that the atmosphere would not cause oxidation. On the other hand, if the torch is held at a small angle the flow of gases from the tip will entrain the atmosphere and carry nitrogen and oxygen over the molten metal.

(4) What is the effect of the distance through which the torch is moved each side of the weld?

(5) What is the effect of playing the torch directly on the welding rod?

If these problems had been studied probably some autographic mechanism could be attached to the torch which would show whether or not the welder exceeded the limits, which research had shown were satisfactory.

Surrounding a weld with non-oxidizing gases, particularly hydrogen, has been found so beneficial in one method of welding which has been recently described[2] that the question arises whether there would not be great advantages in doing the same with the oxy-acetylene flame. If this is practicable, a reducing atmosphere might be maintained which is, I believe, impracticable with the oxy-acetylene torch, as now made, without increasing the carbon content of the weld. If instead of bathing the weld in a non-oxidizing gas, a flux is to be used, it would seem desirable to have the flux from the core of a hollow welding rod. There is no mechanical difficulty in forming the welding rod from a strip of metal formed into a tube.

A thorough experimental study of these possibilities will probably show that some valuable methods have been overlooked.

More data are needed on the fatigue resistance of welds and their strength under high temperatures. It may or may not be necessary to know the fatigue resistance of the weld when designing the welded structures for static loads but when a user of welding asks for this information and fails to get it he can hardly be blamed for wondering why it has not been determined.

When we were asked at the Bureau of Standards to determine the endurance limit of monel metal, I asked where this value was used in design and was told that there was little need for it. However, purchasers of monel metal frequently asked for the physical properties and for the endurance limit because this value for steel was being widely discussed. The manufacturers felt that the cost of the investigation was justified by the purchasers' desire for the information and the values were therefore determined. It is evidently of value in designing monel springs which have since come into use. It is necessary nowadays, for manufacturers to be constantly on the alert to foresee the demands of consumers and in particular to determine by laboratory investigations the weak as well as the strong points of their product. By knowing accurately where troubles may occur the problem is half solved.

Improvements in Apparatus:—As the weight of the torch, particularly in the larger sizes, makes good workmanship more difficult, would it not be desirable to reduce the weight to one-third by using duralumin tube and forgings for all parts except the tip? If desired, the heavy copper tip could be replaced by a thin-walled tube of duralumin or other metal having high heat conductivity. This tip might be surrounded by a larger tube which at the extremity of the top was so formed that the flow of the welding gases, on the ejector principle, would cause comparatively cool air to flow through the larger tube and be expelled at the extremity of the tip.

To produce satisfactory welds a neutral oxy-acetylene flame is necessary. There is good reason to believe that even if the flame is neutral when the work is started that it does not remain neutral under all working conditions. Varying the distance of the tip from the weld usually changes the gas ratio. A careful study of this problem should result in a torch, and regulating devices, which under all working conditions would maintain a neutral flame. This torch might have no gas valves in the torch handle thus again saving weight.

If an investigation shows that no change need be made in the product, the cost is often justified because the detailed information with curves, etc. makes the finest kind of advertising when presented in the proper setting. There is no reason why the purchaser of any apparatus should not receive as definite information regarding what it will do under all service conditions as the purchaser of an electric motor obtains from the performance curves.

The wonderful results which have been obtained of recent years in this country and abroad prove conclusively that research conducted by a skilled scientific and technical staff pays handsomely and is the only way the industries in this country can compete with our cousins abroad. We must develop our manufactured products instead of exporting our raw materials, which are rapidly being exhausted.

The research road lies open before us. Have we the skill and determination to follow it to success or will we let others reap the benefits? It is for your Acetylene Association to decide.

2. General Electric Review, March, 1926, vol. XXIX, No. 3, p. 151—174—Langmir, Weinman, Alexander.

NEW WELDERS' ORGANIZATION IN LOS ANGELES

There has recently been organized in Los Angeles a group called "The Certified Order of Welders," to be known as the C. O. W. for short. It is to be an educational organization. Each welder must be proven to be the best of his kind, whether electric, gas, pipeline or job shop, then the order can recommend him. They aim to improve conditions without strikes by using business methods such as the employer uses. In other words they desire to include only good men who will be in demand.

"We will meet the employer on a common level," says Roy Thomas, one of the organizers, "and arbitrate and legislate. That will take the place of the strife between labor and the employer. In other words we have banded together for a common good and the protection of one another."

It is planned to certify each welder to the employer; the welder must pass an examination before he can become a member. In other words use the employer's tactics. For instance, a member can be expelled for not being a gentleman and a welder, which means fairness to his fellow welders and never to interfere with labor troubles but to lend a hand whenever the opportunity presents itself.

Testing Resistance Welds

No Need for Guesswork in Butt, Flash and Spot Welding When a Microscope Will Reveal Quality of Joints

By J. W. Meadowcroft*

REGARDLESS of the external appearance of a welder joint there are occasions when it becomes desirable to investigate the quality of the weld from every possible angle. The manufacturer who is using welding as a production process must satisfy himself that his product is perfectly sound before putting it on the market. The microscope is a valuable instrument for investigating metal structures because it tells many things which are not seen by the naked eye and often explains the data obtained from physical tests.

Resistance welding calls for careful control methods because when the method is once put into operation its production possibilities are tremendous, consequently the work done by resistance welding machinery has often been subjected to the searching scrutiny of the microscope in order to make sure that this huge volume of work would be as satisfactory in quality as in economy.

In order to have a definite piece of work to use for an example it might serve as a suggestion as to how to use the

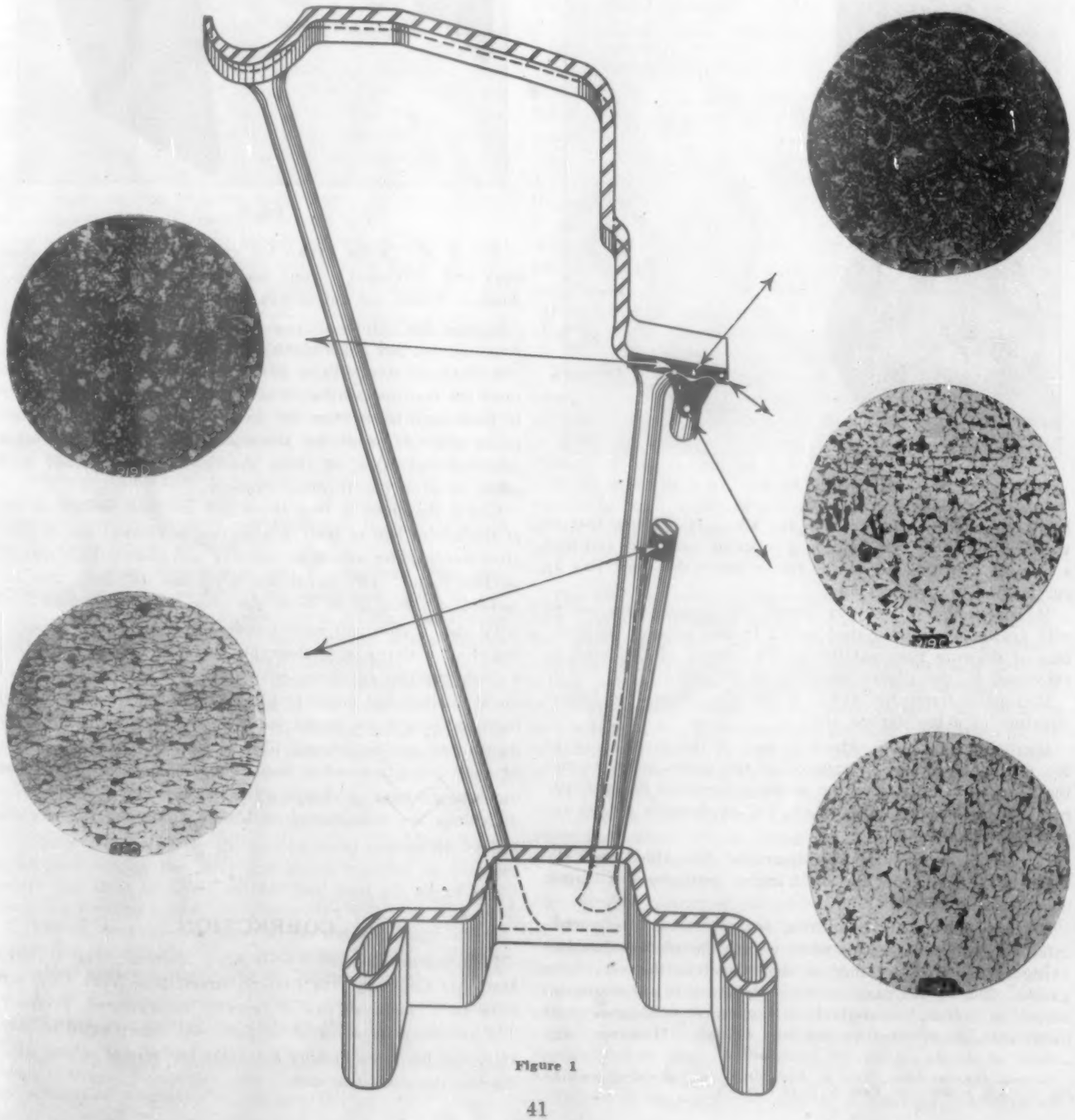


Figure 1

microscope in examining other products, a wire auto wheel in which the spoke was welded to the rim was selected. The position of the microphotographs is indicated in the sketch shown in Figure 1. You will note that the end of the spoke was swaged to shape, leaving a small cavity in the end—a part of which remained unfilled after the welding operation. The drawing also indicates the exact outline of the union between the spoke and the rim. It may be seen that the spoke

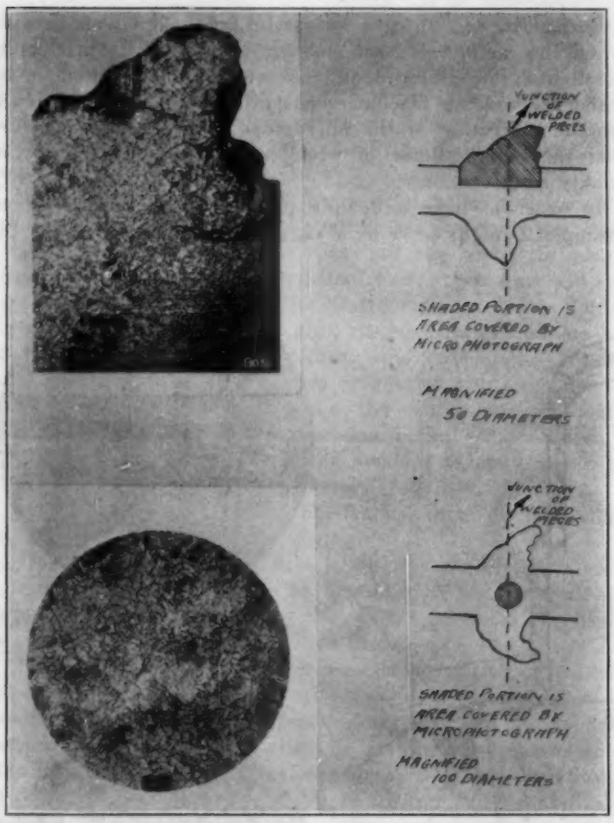

JUNCTION OF WELDED PIECES
SHADED PORTION IS AREA COVERED BY MICRO PHOTOGRAPH
MAGNIFIED 50 DIAMETERS
JUNCTION OF WELDED PIECES
SHADED PORTION IS AREA COVERED BY MICROPHOTOGRAPH
MAGNIFIED 100 DIAMETERS

Fig. 3.

has been slightly pressed into the rim. It appears that in welding, the spoke was held by a collar of some sort and that a plunger then pressed on the rim in much the same way as our method of spot welding.

Microphotograph No. 920 shows the typical structure of cold drawn low carbon steel wire. In this picture, the direction of drawing runs parallel to the bottom of the page, as evidenced by the slight elongation of the grains.

Microphotograph No. 919-C of the rim, shows the typical structure of a low carbon steel.

Microphotograph No. 919-A is part of the same spoke as No. 920. The regular orientation of the grains indicates that the heat produced during the welding operation has partially removed the effect of cold work; i.e., produced a partial annealing of the spoke.

It may be seen in microphotographs No. 919-B and No. 919-D that these areas contain a higher percentage of carbon than the original steels.

We have an equally interesting but somewhat less complicated program of inspection when we use the microscope to investigate the flash welding of sheet steel in the very light gauges. During the past twenty years, much has been accomplished in the various methods of resistance welding of sheet metal with the spot, roller and butt welding. However, very little stress was placed on the flash welding of light gauges of sheet metal due to the difficulty in controlling the expansion and contraction of light gauge sheet steel.

Mr. F. P. McBerty found, in his experiments, that it was possible to flash weld four joints at one time, and developed a machine for flash welding four corners of sedan automobile door panels. The joints were each 2¼" long.

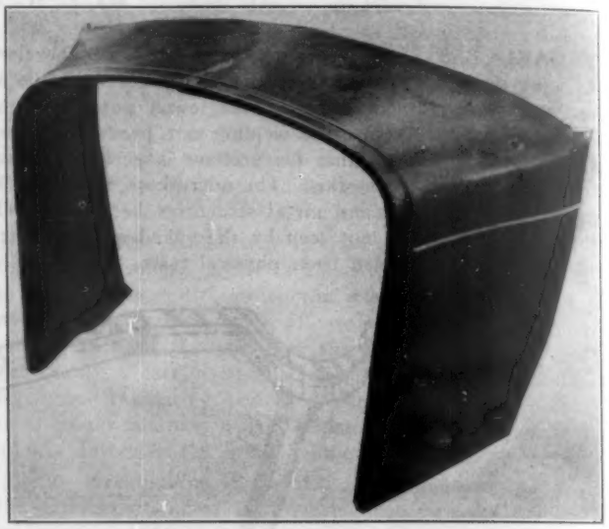


Fig. 2.

Mr. A. C. Taylor began his experiments about the same time and developed a four way machine for flash welding window frames for automobile doors.

Neither Mr. McBerty nor Mr. Taylor stopped with this development, but experimented with machines for flash welding sheets of steel .040 to .050 inches in thickness and developed the machine so that today it is being used commercially to flash weld joints from 12" to 57" in length, on cowls, tonneaus and side panels for automobile bodies, and many other commodities. One of these machines was described in a recent issue of *The Welding Engineer*.

Cowls are made in two pieces and are flash welded on top at the centre line of body. A section is blanked out of cowl after welding, for ventilator opening and cowl is then formed at this point. The joints on cowls are 16" long and are welded at a rate of 60 welds per hour on each machine.

To give a thorough understanding of this method of welding, Fig. 2 shows a photograph of a cowl, flash welded on a flash welding machine, with microphotographs of welded metal in joint and on each side of joint shown in Fig. 3. As these investigations would indicate, the flash welds are very ductile and can be chipped, filed, or ground, the outer surface of weld being somewhat hard, but not sufficiently to cause unnecessary wear on chipping tool, files or emery wheels. No difficulties are encountered in blanking out and forming the welded sections.

CORRECTION

In a recent issue of *The Welding Engineer*, The Welding Materials Company, 114 Liberty Street, New York City, was incorrectly metioned as a recently incorporated company. The company, as a matter of fact, was incorporated in May, 1913, and has been making a regular business of selling welding supplies since that date.

**General Superintendent, Edw. G. Budd Mfg. Co. †Laboratory work by Jos. Winlock, metallurgist, Edw. G. Budd Mfg. Co.*

Selection of a Welding Process*

A New Slant on Welding—"A Necessary Evil"—But in a Steel Foundry the Processes Are Carefully Studied and Used

By L. E. Everett†

THE title of this paper is slightly misleading, and could more appropriately be "The Welding Situation In a Modern Steel Foundry," as that more accurately indicates the contents. While the writer will undertake to describe the conditions leading to the selection of a welding process in the steel foundry, it is to be borne in mind that the selection, and the process, are both confined to steel foundry practice. We are equipped to do welding by any one of three processes, but we do not desire to tell anyone how to select a welding process for any kind of fabricating, or construction work, or even for work in any other steel foundry. We will hereby endeavor merely to tell how we select the process for the welding that we have to do. That you may follow the exposition more closely we will first describe the products of the foundry, the reason for the welding, and the type of welds that we make.

The Nugent Steel Castings Company operates an electric steel foundry with a monthly capacity of approximately 600 tons of small and medium size miscellaneous steel castings. We can make castings of some designs up to several tons, but our average weight per casting is around 25 lbs.

Our production is confined largely to straight carbon steel castings, but in addition thereto, we make alloy steel castings for the more severe service requirements of our customers.

Before proceeding with the discussion of the selection of a welding process it is preferred to first show the relative importance of welding in our manufacturing operations and the precautions taken when welding is required.

In the first place—welding of any nature is a seemingly unavoidable evil in the steel foundry and is used merely as a means to an end. It is used to overcome defects that were not otherwise eliminated, and, while we have improved our foundry practice through some years of intensive and comprehensive research we have not been able to entirely eliminate the necessity for welding.

The art of steel founding is still a long way from perfection and the causes of defects are many and varied.

Some of the defects that necessitate welding, and their causes are given briefly here that the character of the blemish and its extent may be more clearly appreciated.

1. Dirt spots—are caused by small extraneous bodies of sand or other foreign matter lying in the mold cavity.

2. Sand spots—are caused by the molten metal cutting or washing some comparatively loose sand into the mold cavity and entrapping it there.

3. Slag spots—are caused by slag entering with the molten metal, or by the fluxing of the mold surface.

4. Scabs—are caused by the molten metal cutting the mold surface and mixing the sand and metal together in such a manner that areas or layers of sand and steel are mixed superimposed, forming a lump on the casting.

5. Shrink cavaties—are caused by the shrinkage of the steel during solidification when insufficient provision is made for feeding molten metal to the solidifying region.

6. Blow holes—are caused by wet sand, wet cores, hard rammed sand, or anything in the mold that would cause sudden generation of steam or gas, or would prevent the rapid exit of the natural steam or gas when the mold is poured.

7. Cracks—are caused either by the resistance of the mold to the contraction of the cooling steel while it is in a semi-plastic or weak condition or as the result of the stresses set up during this cooling process.

Other defects of a more easily avoidable nature caused by unfamiliarity of the workman with the various castings are:

1. In removing heads or risers with the cutting torch, they are sometimes burned or cut, too low.

2. In flogging, the heads and gates sometimes break back into the casting.

3. In finishing, surfaces are sometimes ground too low.

All of the above and many other defects are preventable, but in a foundry handling as many pieces as we do, from as many patterns, new defects, or new arrangements of old ones, show up daily. While these defects are largely of such a nature that they interfere with the appearance rather than the serviceability of the castings, any evidence of such defect is not tolerated on our finished product. To put it bluntly, we use some welding process to repair all small defects in our castings. It is not a major operation, not a vital accessory to our finishing department, but we do it because a casting of better appearance, and in some cases more serviceable nature is assured through the judicious use of one or the other of our welding processes.

This brings us to the point of defining the rather vague zone, as to whether we would weld a defective casting to save it, or decide to scrap it. In general if the defective area is small and in a location where it has little effect on the strength of the casting we would weld it.

If the defect is large, and where the cost of welding would exceed or even approach the cost of remaking the casting, or the strength and service value of the casting would depend largely on the weld, we very much prefer to remake the casting.

The users of steel castings realize that many of the castings have defects which do not interfere with the usefulness, but which do impair the appearance of the casting. Many foundries use cements and fillers to cover up these defects; others weld the spots without cleaning them thoroughly; in other words, they merely fill the holes, or cover up the spots and call it a job. These practices are now frowned on by the leaders of the industry, with the result that the welding practice of the steel foundries as a class, is improving.

As a member of the Electric Steel Founders Research Group, The Nugent Steel Casting Company adheres to a very rigid, strict and severe set of Inspection Standards which govern their welding practice, and provides as follows:

First—For repairing small defects of any kind, the use of any metallic cement or smoothing filler is strictly prohibited.

Second—The repairing by welding, of any cracks or other defects, however small, shall be permitted only when authorized by the inspectors or their superiors who are personally responsible for the strict application of the Inspection Standards. Cracks, blow holes, or shrinkage cavities shall be thoroughly opened up before welding. All sand, slag, or other foreign matter shall be removed by cutting down to clean, sound metal before welding.

Third—As a precaution against a slovenly workmanship

*Paper read before International Acetylene Association Convention, Chicago, November, 1920.

†Nugent Steel Castings Co., Chicago, Ill. Research Engineer.

no welding operator shall be compensated on a piece work basis, or wage plan involving any premium for quantity production.

It is realized that when castings are welded, stresses are set up, which are similar in character, but less in extent, to those caused when the casting solidifies in the mold. The composition of the weld differs from that in the casting proper, because the heat applied in welding is sufficient to allow some of the elements in the welding rod to oxidize, or otherwise change their nature. The quicker cooling of the weld metal gives it a different structure than the metal cooled in the sand mold, and frequently this more rapid cooling also gives the weld metal a greater hardness than has the metal in the casting. For these reasons our Inspection Standards also provide that all castings shall be heat treated after welding, to render the weld metal more nearly like that of the casting in composition and structure. Our welds are largely of such small size, and our heat treatment sufficiently thorough, that homogeneity is practically attained on all welded castings.

In order to explain the selection of a welding process and the care that is evidenced in making this selection, it is necessary that we first digress sufficiently to show our preliminary cleaning and finishing routine.

Castings enter the cleaning room in two ways. The smaller castings coming from the shake out floor, have their heads or risers and gates either flogged off, or cut off in a sprue cutter, and are then taken to the Tumbling Barrel or sand blast where all adhering sand is removed. The larger castings go direct to the sand blast, or to a special chipping floor, where the sand is removed from the "neck" of the risers and then these heads are removed by means of the oxy-acetylene cutting torch. Castings of both classes are then collected on an inspection floor where they are carefully gone over for defects.

Castings having minor defects that can be repaired by welding are marked up (that is, the defective areas are outlined with chalk) and the inspector sends them to one of the welding units.

We have welding equipment for the following processes:

1. The Bare Metallic Electrode Process.
2. The Carbon Electrode Process.
3. The Oxy-Acetylene Process.

A chipping floor is arranged in conjunction with each welding unit, and all defects to be repaired are first chipped out to clean solid metal. In the majority of cases, where the weld is at all important, the chipping is passed on by the inspector before the casting is permitted to go to the welder. In this manner a base of sound metal is insured for the weld.

As to the selection of the repair process; the size of the casting, the size, character, and location of the defect, the type and application of the casting, all have a bearing. The cost, and productive capabilities of the processes must also be considered.

Let it be strictly understood here that we are making no claim for the superiority of one process over another. We merely indicate what our own experience, guided by our own research, has been and the application we make of these processes to our practice.

Consider first the Bare Metallic Electrode welding process. This is used in our plant to make small repairs such as are made necessary by slag and sand spots, small blow holes, etc. We also use this process on surfaces which are to be subjected to machining operations. Generally speaking, the application of the metallic electrode is confined to our smaller castings, and the smaller defects on the larger castings. We find welds made by this process to be well fused with the casting metal, and to be sufficiently strong, ductile, and soft, after the thorough heat treatment of the casting, to be machinable, and apparently satisfactory.

In regard to the Carbon Electrode Process, or Carbon Arc Welding as it is called; we find its greatest application in welding the larger defects in the larger castings. Due to the propensity of the arc to deposit carbon in the weld metal, this process is seldom used on the surface of the castings that are to be machined. We find it to be the quickest and cheapest way of adding any appreciable amount of metal and the welds are seemingly sound, and sufficiently strong. In using this process, recourse is had to the scratch brush and the hammer and satisfactory welds of fairly large size are comparatively quickly and cheaply made. As mentioned before, this carbon arc is used more on our larger,—and hence more rugged classes of work. It is not used on surfaces to be machined; and it gives us a weld that with proper dressing, and after thorough heat treatment, is thoroughly satisfactory for this type of casting.

The oxy-acetylene welding process is used largely in welding for leaks in our pressure fittings, or elsewhere, when the strength of the weld, and its soundness are of primary importance. In other words, when it passes the stage of appearance, and the service capabilities of the weld are of prime importance this process is used.

The oxy-acetylene process is used for this class of welding for several reasons—

First on account of the slightly reducing characteristics of the normal flame, less oxide inclusions and less slag are incorporated in the weld, than with the other or arc processes. This yields a stronger, denser, cleaner weld with superior ductility. The second point is that welding for leaks or for serious defects in pressure fittings requires the best of workmanship—and it is very much easier to exercise close supervision over the gas welding than it is to do the same for either of the arc processes.

In areas that are to be subjected to extremely close machining, and where perfect, sound surfaces must be maintained, such as valve seats, we find we can place greater dependence on the oxy-acetylene welds than we can on the arc product, and therefore it alone is used for this class of work.

Occasionally a weld must be made on a casting, of the "rush" variety, a break down job, and after all the finishing operations, including heat treatment, a defect, unnoticed before, is found. If the customer agrees, the defect can be oxy-acetylene welded, and the re-heat treatment waived, as a perfectly sound, soft weld can be put in with the torch, and the stresses sufficiently relieved by proper manipulation. This enables us to save the customer the delay which would otherwise be caused by the heat treating operations and, withal, gives him a satisfactory casting.

We find an occasional application of oxy-acetylene welding in our actual manufacturing, and it has, at times, enabled us to produce castings at a considerably lower cost than would have been the case without it.

I recall an instance where our facilities were quite inadequate for the manufacture of a certain casting. Through oxy-acetylene welding, which became for that particular time, one of our major operations, we were enabled to satisfactorily and economically complete the job.

The casting was a ring of reinforcing band, 90 in. in diameter, weighing about 300 lbs. and the cross section—U Shaped, provided for metal about ½ in. thick. We did not have a flask in the shop capable of taking this pattern, nor could we get the entire ring in our annealer, and it was either necessary that we make a special flask and deliver the casting unannealed, or cast the ring in two halves and weld them together. We decided on the latter procedure and made several castings on the original order, joining the two halves with oxy-acetylene welding and they were so acceptable that we have received repeat orders.

Also, there is a case of a 24 in. pipe cross, 600 lb. test weighing 5,400 lbs., which was part of an order for cast steel fittings for a high temperature, high pressure, steam installation of an Eastern Power Company. This casting was specified to be finished without welding of any character, and due to a change in design of the installation, it became

necessary to provide certain additional side outlets on the cross after the casting had been finished. The casting had been tested, proven satisfactory, and had been accepted by the customer when this revision was made. In order to prevent the loss of the casting, which naturally was a very expensive piece of work, the additional outlets were oxy-acetylene welded in place, the casting was re-tested accepted, has been installed and is giving entirely satisfactory service.

From the foregoing it might seem that oxy-acetylene welding is one of our major processes. Such is not the case. Ordinarily welding is one of the minor functions of our finishing department and such welding as we do is largely incidental to the appearance of the casting. There are times, as the two foregoing examples illustrate, when we do place a great amount of dependence on welding.

While we do a very considerable amount of welding, we are not proud of the fact. Every weld represents a defect—repaired, and while the castings as received by our customers are perfectly satisfactory, the welding or repairing of these defects is but an added, and unavoidable, cost burden to us. Realizing that it will be some time before the manufacture of steel casting can be controlled so as to eliminate defects in the product, we have more or less concentrated on the obvious means to the end. We are regulating our welding or repairing practice, by exercising the greatest precautions, by using the optimum method for the case in hand, and by thorough heat treatment after welding so that we are enabled to maintain the highest quality in our product. By citing the care, and attention, this phase of our finishing routine receives, as evidence of the careful and scientifically applied practices throughout the shop, we have been able to convince our customers, and the trade in general, that the quality of our castings is extremely high. Also, by our actual concrete performance we have kept them so convinced. This has quite naturally had considerable effect on, and has been reflected in, our volume of business. And after all, to paraphrase Mr. Linde, it is procedure control that does it.

F. M. FEIKER BECOMES MANAGING DIRECTOR

Associated Business Papers to Carry Forward a Broad Program for Making Industry Opinion

Jesse H. Neal, who for eleven years has served as Executive Secretary of The Associated Business Papers, has resigned, his resignation effective January 1st. He and Mrs. Neal will leave on a six-months' Mediterranean trip in January. The Executive Committee of the A. B. P. have created a new office for the association, that of Managing Director. Frederick M. Feiker has been appointed to this office. After January 1 the headquarters of the A. B. P. will be located at 52 Vanderbilt Avenue, New York.

Frederick M. Feiker has been appointed managing director of The Associated Business Papers, Inc. The coming of Mr. Feiker marks the inauguration of a more active policy and a broader program for The Associated Business Papers in the promotion and development of higher standards of journalism for the business press.

Mr. Feiker brings to the A. B. P. a background of experience singularly fortunate for the work he is to do—embracing fifteen years as editor and publisher, a year and a half in the U. S. Department of Commerce, three years in trade association leadership and a practical experience in educational work. Here in combination are four elements which, to use his own words, are "the fundamental influences in the making of industrial opinion and the forwarding of American commerce."

"Four major forces are working to this end," he says. "These are—

1. Trade associations where men of an industry gather for personal contact and cooperation in analyzing conditions, establishing principles, defining policies and promoting harmony between competitors.

2. Business schools and engineering colleges engaged in turning out young men for industry, loaded with book knowledge and with a well developed appetite for study.

3. Government bureaus and departments that serve or exercise control over industry or commerce.

4. The business press, functioning for engineering, trade and industry, that ties together all the contributing factors and provides a practical medium for the flow of news, discussion, experience, continuing study and progressive thought."

In the coordination of these four influences directed to the science of industry, lies the great opportunity of the business press today, the last stronghold of individual journalism. And it is for the purpose of effecting a broader effort by the institution of the press organized as the voice of industry that the A. B. P. has established the new office of managing director and is moving into larger quarters at 52 Vanderbilt Avenue, New York, under this promising leadership.

Mr. Feiker has had an interesting career from the standpoint of the new job. He was born in Northampton, Mass., in 1881 and was graduated as an electrical engineer from Worcester Polytechnic Institute in 1904. He then became "technical journalist" for the General Electric Company, writing for trade and industrial papers. In the course of this work he made a detailed study of the editorial problem of all the papers by personal contact with the editors, and became convinced of the need for a "horizontal" paper to serve the executives of all industries. In pursuit of this idea he joined the A. W. Shaw Company and established the magazine *"Factory,"* and later was made chairman of the editorial board for *System* and *Factory*. While with Shaw he spent two winters on leave at Harvard University helping to organize the industrial courses in the Harvard Graduate School of Business and lecturing there. In 1915 he went with the McGraw Publishing Company as editor of the *Electrical World* and guided the early development of *Electrical Merchandising*, becoming eventually vice president and editorial director of the McGraw-Hill Company.

In 1921 Herbert Hoover invited Mr. Feiker to join him in Washington as assistant to the Secretary of Commerce, to personally aid him in carrying out plans for the reorganization of the Department of Commerce in its relations with trade and industry, and he secured leave from the McGraw-Hill Company and spent eighteen months in government work. During that period he established the Division of Simplified Practice in the Bureau of Standards, revamped the Bureau of Foreign and Domestic Commerce on the basis of service to commodities, assisted in the organization of the monthly survey of business statistics in the Bureau of Census and remade the Department's publication, "Commerce Reports," besides acting as advisor on personnel for the Department as a whole.

It was during this period that he became impressed with the need for organizing the common interests of diversified industry to coordinate and direct their relationship with the Government, the educational institutions and the press. It was in line with this thought that in cooperation with A. C. Pearson, now Chairman of the Board of Directors of the United Publishers Corporation and Edward J. Mehren, Vice President of the McGraw-Hill Company, he arranged the monthly conferences of the National Conference of Business Paper Editors with Mr. Hoover in Washington that have continued now for three years, and out of which has grown a continuous close contact between the government bureaus, the United States Chamber of Commerce and the business press.

When this work was completed in 1923, Mr. Feiker became operating vice president of The Society for Electrical Development, where he has done an outstanding job in organizing competitive commodity promotion campaigns for groups of manufacturers. Here he has proved out his belief that "competition and the cooperative development of ideas and markets are not antagonistic forces in industry, but coordinate and supplemental influences. In short, cooperation should be "the working partner of competition in every field of business activity." He now leaves the Society to undertake the executive management of The Associated Business Papers.

Mr. Feiker is a trustee of Worcester Polytechnic Institute, a director of the Franklin Society for Home Building and Savings, of the Ward Motor Vehicle Company, and member of the American Institute of Electrical Engineers, the American Society of Mechanical Engineers, the American Association for the Advancement of Science, the American Academy of Political and Social Science, the Washington Engineering Society, the Illuminating Engineering Society and the Engineers, Advertising and City Clubs of New York, the University Club ot Chicago and the Cosmos Club of Washington. Mr. Feiker also holds the title of "Expert Consultant" to the U. S. Department of Commerce, and is vice chairman of the Advisory Committee on Distribution Statistics, of which Owen D. Young is chairman, and a member of the Advisory Committee to the Division of Domestic Commerce, of the Bureau of Foreign and Domestic Commerce, both appointed by Mr. Hoover.

WELDING AND THE NATIONAL POLICY

By Netting Industry an Annual Saving of Four Hundred Million Dollars, Oxy-Acetylene Welding Enhances American Economy.

When the late President Harding assumed office in 1921 and brought Herbert Hoover into his cabinet he inaugurated an administration which put all its weight behind a policy of industrial and governmental conservation and standardization. Chiefly because of his war service but partly because of his record since he has been Secretary of Commerce, Mr. Hoover has succeeded in having his name linked with conservation, economy and elimination of lost motion. When these policies were continued and furthered under Mr. Coolidge, the people of the United States came to be impressed with the advisability if not the actual necessity of being economical.

Concentration on this policy by the National Government has been reflected in business, and, as in government, a business regime in which economy is the paramount thought has grown up. Executives have become imbued with the desire to make more money by saving more money. At the present rate, there is not a prospering industry in the country which is not scheming to reduce production expense at every turn, and from many fields we are continually hearing of phenomenal savings being made by this new project or that new device.

One of the most startling disclosures which has been made along this line is to the effect that four hundred million dollars annually are being saved by the single process of oxy-acetylene welding for American industry. To be sure, this process is nothing new, it has been used in repair work for years with great savings. Recently, however, savings by oxwelding have been assuming tremendous proportions.

Production delays arising from machinery breakdowns are a great cause for expense to plant owners. They are certain to arouse the dissatisfaction of customers and are apt to lead to the actual cancellation of contracts. In either event the plant loses prestige. As a result, it is quite naturally the desire of plant managers to have production held up as short a time as possible, and they have consequently adopted oxy-acetylene welding as the process which serves to repair broken machinery in the quickest possible time and with the greatest degree of permanence.

Besides the fact that it enables a plant to resume operation within only a few hours after cessation, oxy-acetylene welding makes broken machinery as good as new and at a fraction of the replacement cost. This saving is only secondary to the saving in time and prestige. That is an intangible saving connected with good will and can not be estimated. Yet it has been found that throughout the country this secondary saving of repair over replacement cost amounts to the astounding sum of four hundred million dollars a year.

This estimate is the result of an extensive survey of instances which have offered definite figures for the repair cost of machine parts and the cost of new parts for replacement. The instances vary from a "horse-head" valued at 50 cents and repaired for a nickel, to a shear guide costing $1,000 and repaired for $600. Averaging the repair and replacement costs gives a good cross-section of the repairs made day by day in industrial plants throughout the country. By this method it has been determined that the average machine part can be repaired at a cost of one-seventeenth the cost of a new replacement part.

Allowing 100 per cent for overhead in the repair shop, the cash saving is 7½ times the repair cost.

By analyzing further data ranging from the 60 cent repair of a small housing to work done on a locomotive frame repaired for $463.52, it was discovered that oxygen represented one-sixth the cost of labor, gases and supplies. This means that, including the overhead, the oxygen represented one-twelfth of the entire cost.

Now if the total amount of oxygen used for repairs could be estimated the data could be translated into a total for the country. Admittedly only a small fraction of oxygen made is used for this purpose, in comparison with the large amount used for cutting and for new construction and production. Four well-qualified men discussed this situation and concluded that about 300,000,000 cubic feet of oxygen were used annually throughout the United States for repair purposes.

If industry pays one and one-half cents per foot for this gas its annual oxygen bill for repair purposes is $4,500,000. The total cost of the repairs made with this amount of gas is 12 times that figure, or fifty-four million dollars per year. However, the net annual saving is 7½ times the repair cost, or $405,000,000.

An enormous saving! Clear profit. Then add to this figure the savings in time and profits, and you immediately see why the oxy-acetylene process for repair holds first place in every American mill and factory. It is in this fashion that oxy-acetylene welding serves to help industry carry out the national policy of economy, a policy which is so vital a cause for American world prominence today.

GENERAL ELECTRIC ANNOUNCES TWO-ARC AUTOMATIC

Welding heavy plates automatically at approximately ten times the speed which can be obtained with the single-arc manually controlled process, is now possible with a new automatic arc welder announced by the General Electric Company. The new machine bears the designation Duo-Arc Automatic Welder and consists of a standard travel carriage on which are mounted two automatic welding heads, and two reels of electrode wire. With this equipment, the manufacturers claim, the operation is just as simple as that of the single arc travel carriages. One attendant can supervise the two welding arcs as easily as he can one arc.

The new welder is of particular value in butt welding heavy plates. This is accomplished by two electrodes working one behind the other simultaneously. Thus the necessarily large quantity of metal required to fill up the seam is deposited in practically one half the amount of time which would be required for the travel of one electrode.

The ordinary method of depositing the required thickness of metal in welding heavy plates is to weld twice with a single electrode over the same seam.

By using two electrodes, welding simultaneously, the time required to repeat the welding with a single electrode is saved.

An electrode larger than ¼-inch in diameter is not commonly used for high grade work because the deposition of metal cannot be accurately controlled and it is inconvenient for operators to handle the large amounts of electrical energy necessary, concentrated in a single arc.

For welding half-inch plate, the seam is prepared by beveling to an angle of 30°, total opening, with ⅛-inch electrode and approximately 250 to 300 amperes in each arc, a speed of welding of from five to seven inches per minute may be obtained. The manufacturers state that the speed of welding is approximately ten times that obtained with a single arc manually controlled and the resulting weld is of better quality because of the decreased chance of burning the weld.

ARC WELDED LOCOMOTIVE FRAMES

By H. H. Marsh

We have been making quite a study of welding locomotive frames with the electric arc in Australia and the photographs shown here illustrate the results of some of our experiments. Number 1 shows a weld in the left hand side of a bar locomotive frame partly completed. Number 2 shows the same weld completed. The left cylinder has been removed from the locomotive. The fracture in this case occurred through one of the vertical bolt holes which carries the cylinder bolts. This was welded with $\frac{5}{32}$-inch bare wire Armco electrodes and reinforced in the overhead position with $\frac{1}{8}$-inch diameter Quasi-Arc slag covered electrodes. The total time of welding was about ten hours. This welded frame has been in everyday service for three months and appears to be o. k. The right hand side of this same frame was welded in exactly the same place eighteen months ago and it is o. k. Another engine having a smaller fracture was welded the same way twelve months ago and is still giving daily service.

The third photograph shows a partly completed weld in a 3 inch by 3 inch locomotive frame, and number 4 shows the completed weld. The fracture occurred at the edge of an older weld which is shown cut away to make room for the new repair. This weld is long in service at the time the story is being written. It was welded with Quasi-Arc slag covered electrodes No. 4 and No. 10.

Photographs 5 and 6 show a locomotive frame which is made of 1-inch plate with 7-foot strips two inches wide and $\frac{7}{8}$-inch thick welded on the top edge on both sides. In altering the design of these engines it was found necessary to lift the boiler two inches and this is how it was done. These strips also helped to stiffen the frames which have often fractured at the point marked "A" in photograph number 5 or on the opposite corner. We welded these strips on with 5/32 and $\frac{1}{8}$-inch electrodes. The average time of welding was twenty-two hours. I have welded thirty of these jobs and have heard of no fractures yet.

In photographs 7 and 8 are shown the preparation and completed job in a 1-inch plate frame similar to the ones shown in the two preceding photographs. The fracture occurred through an older weld which had been in service for eight years. The old weld was cut away and a new piece of plate welded in as shown. The remainder of the crack was veed out and filled up with the electrode. The dotted lines in photograph number 6 shows the location of the weld better than a close-up view does. This was welded with Wilson No. 9 flux coated electrodes $\frac{1}{8}$-inch in diameter. The contraction between "A" and "B" in photograph 7 was 3/32 of an inch. Altogether the experience we have had with these jobs has been very successful.

ARC WELDING FOR GAS PIPE LINES

Gas companies are not slow in adopting welded joints, once they become thoroughly familiar with the advantages of this type of construction. The illustrations reproduced with this article show some of the work done at the Consumers

Gas Line In Ditch

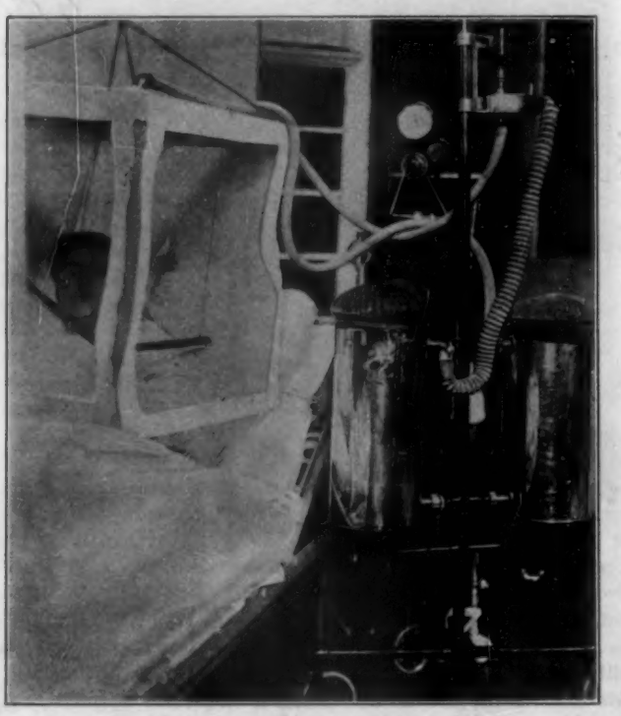
Power Company. This company recently laid seven miles of six inch pipe, which was joined by electric arc welding. Gas will be carried through this line at a pressure of sixty pounds. For making the arc welded joints a General Electric W. D. type of generator was used on this job. On a part of the work a one-eighth inch electrode at 125 amperes was used and for the rest of it 5/32nd inch electrode at 150 amperes was used.

Some Arc Welded Locomotive Frames

OXYGEN PLAYS ROLE OF NURSE

Oxygen is now playing the role of nurse, the kind of nurse who is not forever pestering the life out of a patient, trying to make him comfortable and succeeding only in annoying him beyond words but the kind who lets him alone in peace and so helps save his life.

In the air we breathe there is a little more than 20 percent oxygen and if that is not enough for you, you will know it. Because, when the amount of oxygen has to be increased for a person, that person is not very far from the borderline. About 200 years ago it first occurred to doctors to provide an additional percentage of oxygen for pneumonia patients. But the systems devised for doing this were as unsatisfactory as they were crude, and it was put down in the books that surplus oxygen had no value as a life-preserver or restorer. During the war, however, the effective administration of oxygen was realized in the treatment of gassed soldiers. But here



Oxygen an Aid in Treatment of Pneumonia

again the methods of supplying extra doses of the element were crude, and the soldiers objected pretty generally to receiving the doctor's present in the only wrapper in which he was able to give it to them. They didn't like wearing the catheter inserted in their nostrils, any better than they liked the oxygen mask. But war being what Sherman said it was, forced them to submit to the only kind of treatment then available.

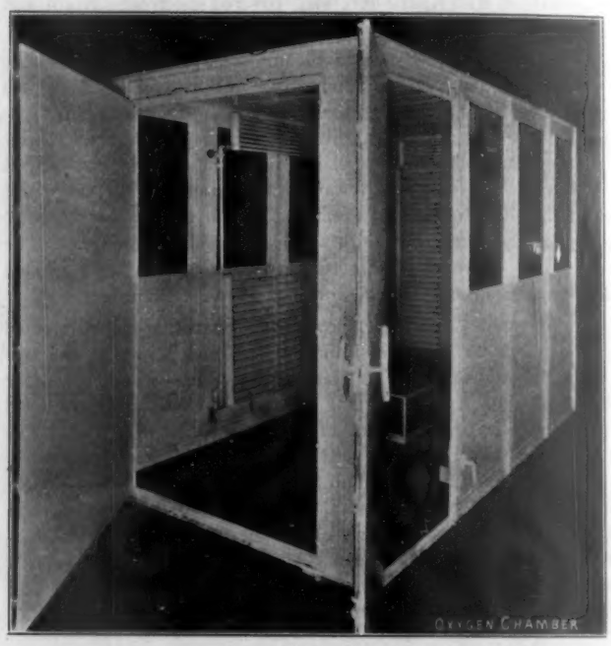
Lately, Dr. Alvan L. Barach, of the Presbyterian Hospital of New York City, has used effectively a large oxygen chamber, or room, in which the patient is placed at no inconvenience or discomfort to him whatsoever. This chamber has been the development of a series of other modes of administering oxygen, from the tent which was placed over a patient's head to a less satisfactory chamber than the one now being used.

In this chamber the proportion of oxygen in the air is brought up to between 40 and 60 percent. (Air normally contains but 20%.) More, it is believed, might not be as satisfactory. The temperature of the room is adjusted to suit the patient's wishes, and the air is kept in constant circulation. Aluminum pipe lines are placed against the walls. The air in contact with this pipe is chilled, the moisture condenses on the surface of the pipe, and the cool dry air passes to the floor of the chamber where the carbon dioxide is removed by a purifier in the form of trays of soda-lime. The air, warmed by the heat of the patient's body, passes to the roof with additional moisture and carbon dioxide. It is then chilled again and the process repeated.

The first chambers were those of Dr. Stadie at Rockefeller Institute and Dr. Barcroft at Guy Hospital, England. They both operated with motors. No motor or electrical apparatus is required for Dr. Barach's chamber.

This unique chamber is made of aluminum plates welded together to make it air-tight. It is valued at $2,500, and there are only five of its type in the world, two in England, one at the Mayo Hospital in Rochester, one at the Rockefeller Institute and this one at the Presbyterian Hospital in New York City. The oxygen is supplied from a high pressure cylinder outside the chamber. In commercial size cylinders, such as is used for welding purposes, it is so cheap that the operating cost of the chamber is well-nigh negligible.

Thus far the oxygen chamber has proved itself, and Dr. Barach believes that its use will be adopted by more and more hospitals as its work becomes better known. But as the result of the indifferent success with which early experiments met, it has an uphill fight ahead to overcome the tradition which men of science have come to associate with it.



Special Chamber for Treatment with Oxygen

In sixteen clinical cases treated under Dr. Barach's supervision and reported by him, the results of supplying pneumonia cases with extra oxygen have been encouraging. Ten of those cases were treated with the oxygen tent, and of these seven recovered. All but one of them were severely critical. Of the six cases treated with the chamber, four recovered.

The development of this chamber is an example of the type of work being carried on at the Presbyterian Hospital, which is co-operating with Columbia University to form the largest medical center in the world.

He feels that there is no question about the service performed by oxygen in helping pneumonia cases. While he does not say that it is a curative, he believes that it is obvious that it is a supportive; that is, that it prolongs the life of a patient until he shall have passed the crisis and is able to accomplish a normal recovery.

So when you breathe the air around you, you may know that you are breathing in a drug whose pharmaceutical value is just beginning to be realized, and which, if you should get your feet wet and develop pneumonia, may help nurse you through a critical period to recovery.

ARC WELDING AT ITS BEST

The best boosters for the job welding shop are those who have had work done and secured a result which would have been utterly impossible without welding. Many instances of this kind occur in the practice of an up-to-date welding shop. From one of these, the Western Welding and Equipment Company, of Chicago, Illinois, come photographs of two particularly interesting pieces of work. The first of these is shown

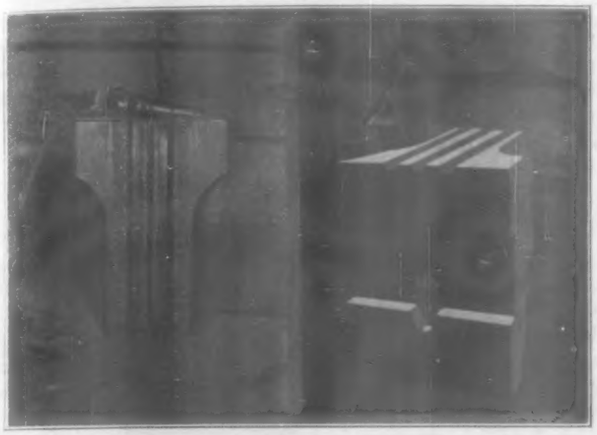


Fig. 1. Before and After Machining

in Figures 1 and 2. At the left in Figure 1 is a large forging which has been made for a big manufacturing plant and just before it was delivered it was found that the grooves had been incorrectly designed. To scrap such a piece would have meant taking a considerable loss on account of the size and the amount of machine work which had already been done on it. Some one suggested welding and an investigation was made to determine whether this would make it possible to save the forging. Samples of steel of the same analysis and physical properties were built up with the electrode material which it was proposed to use for the job and the result was subjected to very searching tests. Following the tests it was decided that welding would save the piece. Figure 2 shows the welder completing the last layer of metal. The forging with the incorrect grooves filled in is shown at the left in Figure 1 and the finished job after machining is shown at the right in Figure 1. This was a good job for the shop and also for the customer because it reduced the cost of a factory mistake by hundreds of dollars.

At the left in Figure 3 is shown a steam bucket which is doing almost continuous duty loading and unloading building

Fig. 2. Welder at Work Reclaiming Spoiled Piece

materials in the yards of a large Chicago firm which deals in such materials. When in service the whole outfit is constantly working through just a portion of a circle. Consequently the gear teeth of the drive mechanism became worn only in certain sections. When they become worn down to the point where the mechanism does not operate smoothly a repair job would be a serious matter if it were not for welding. The photo at the right in Figure 3 shows the location of the points of greatest wear. To dismantle the entire structure in order

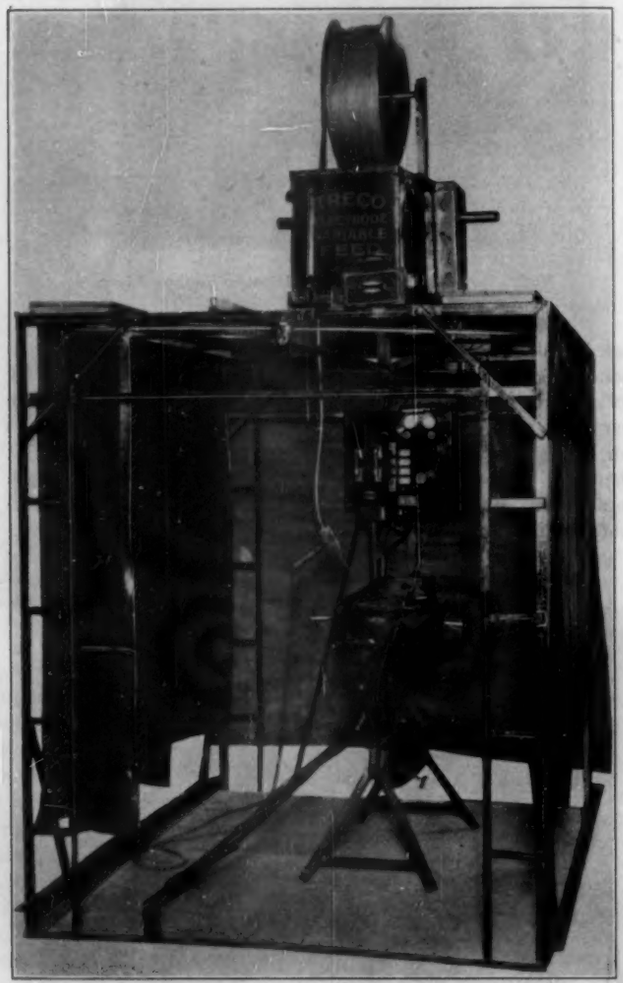
Fig. 3. A Little Bit of Welding Saves a Huge Dismantling Expense

to replace this gear it would take a great deal of time and involve huge expense bills. But it is no trick at all for the welder. When repairs are necessary he brings a portable outfit to the scene of action, runs his leads up to the worn gear and one by one builds up the worn teeth in less time than it would take to dismantle it and at less cost.

In the central picture in Figure 3 are shown Mr. Jardine, proprietor of the Western Welding and Equipment Co., and one of the many skilled welders whom he keeps busy most of the time. Mr. Jardine takes a great personal interest in jobs of this nature because since they do work which cannot be done in any other way they show off the process to the best possible advantage and make strong friends for the whole industry.

TRECO SEMI-AUTOMATIC ELECTRODE FEED

The Truck Equipment Company, Buffalo, N. Y., recently placed on the market the "Treco" semi-automatic arc welding head which can be used with any type of welding machine and is especially adaptable for production welding.



Treco Semi-Automatic Electrode Feed

It is a variable feed control and a wide or narrow fusing of bead is made without breaking the arc. Speed of the electrode feed is controlled by a foot lever accelerator. No carbon resistor, rheostat or variable speed motor is used. Advantages claimed for the use of the device are: Welding rod is used in coils and costs less; no short ends wasted; no time lost in changing rods; neater and better welds are accomplished; lower power cost; no idle minutes; the welder is depositing metal more minutes per hour; increased speed of weld is accomplished with a maintained heat.

The holder is cool and flexible, easily guided and reduces operator's fatigue. Welds overhead, vertically and horizontally.

TRECO variable electrode feed is made in three different types. One type has a semi-automatic feature with an overhead feed. This type of unit is designed for production seam welding up to 12 feet. In fact, this unit can be used for any type of welding where the product to be welded can be placed in the welding booth which is a part of the equipment.

This semi-automatic portable outfit is furnished either in truck form which can be pulled around the job shop or made a part of the portable welder unit. With this machine the feed control is operated by a trigger switch on the electrode handle. Through this means of operation any speed of wire-travel can be accomplished.

MONARCH ELECTRIC ARC WELDER

The Monarch electric arc welder now being manufactured by the Monarch Electric Welder Company of Des Moines, Ia., has been devised to meet the most strenuous conditions under which arc welding may be done. Intense penetration, a highly developed system of regulating the temperature of the arc, extreme simplicity, and twenty-four hours of continued service a day are features claimed for this machine, which is of the transformer type.

The Monarch machine is used in welding iron and steel, cast and malleable.

The arc temperature can be utilized in both large and small iron and steel projects, in a degree commensurate with the size of the work in hand.

New Monarch Arc Welding Transformer

A special feature of the new arc welder is a series of impedance coils fabricated from a low annealed steel, with a certain per cent of manganese. A coil has been devised that will retain a tremendous amount of heat, but will readily cool, and at the same time provide an even flow of current and sufficient resistance to give the operator a strong and steady arc. There are thirteen of these impedance coils, arranged around two circular bands of hot rolled steel. These coils are connected with power plugs or terminals arranged systematically on the front surface of the casing which is made of steel sheets. Each lug of varying amperage, gives service from a certain set of coils, either four or one as desired by the operator.

An electrode holder is provided which may be used on any length of cable up to 500 feet. Cable lengths in excess of 500 feet will cause loss in voltage, which will lead to an insecure weld, and will also cut down the amperage required on the larger projects. However, the machine, weighing only 275 pounds, occupies a space of only three cubic feet, and is readily portable.

METALWELD RUNABOUT ELECTRIC WELDING GENERATOR

The Metalweld "Runabout" Electric Arc Welding Generator or Lighting Generator Unit, mounted on a special framework to the Fordson Tractor, has just recently been placed on the market by the Metalweld Service Corporation, 2617 Hunting Park Avenue, Philadelphia, Pa.

This unit consists of a Fordson Tractor mounted either on rubber tired or iron cleated wheels and a Metalweld framework which has been designed to mount either a Lincoln, General Electric or Westinghouse welding generator of the popular 200 amp.-300 amp. size.

The complete unit is very compact and the welding gen-

Metalweld Runabout.

erator is driven by a power take-off shaft which is controlled by an independent clutch. This allows the tractor to move about on its own power and run from job to job using but one engine to drive the tractor and the generator.

The gasoline engine runs at a continuous speed of 1000 r.p.m. when driving the welder and is controlled by a fly-ball type governor. The engine develops 24 hp. at this speed.

The Metalweld framework is furnished complete with all accessories ready to bolt on to the standard Fordson tractor and it is merely a two hour job to have the entire unit ready to go to work.

The electric welding generator is belt driven from the power take-off and the belt is tightened by means of a slide rail base on the welder.

NEW IMPERIAL OXY-ACETYLENE EQUIPMENT

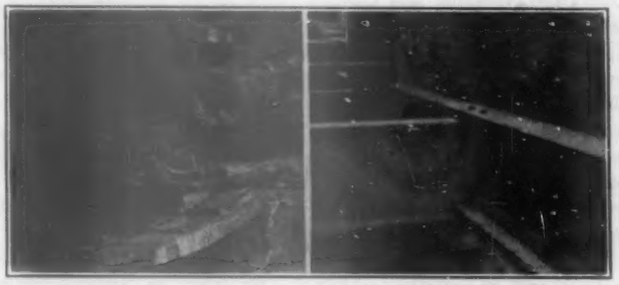
The Imperial Brass Manufacturing Co., of Chicago, have announced a complete new line of oxy-acetylene welding and cutting torches and outfits. The new standard welding torch is called

New Imperial Type X Torch.

the Type X and has been designed to perform all welds within the limits of the oxy-acetylene process. It embodies a new mixing principle which, it is claimed, insures accurate control of gases and thus assures successful welds.

AN INTERESTING CAST IRON CUTTING JOB

In connection with some building operations in Chicago a short time ago the oxy-acetylene cutting torch was called into service to perform an interesting operation on cast iron. In getting ready to put up the steel frame work of a new building the builders found that a large piece of cast iron, which had formed a part of an iron pillar in an adjoining building, stuck out so far that it was in the way of the erection of new work. The usefulness of the cutting torch in general is so well known that the construction companies almost always have a cutting outfit and an operator on the job, or at least available on short notice. In this case, however, the operator was not familiar with the cast iron cutting process, but since he was skillful enough in the use of the torch it was not a difficult matter to help him develop the necessary technique to make this cut in a satisfactory manner. The photograph at the left in the illustration shows the objectionable piece with a part of the casting already cut away. The dotted lines indicate the remaining cut that was necessary in order to get completely rid of the obstruction. The photograph at the right shows the steel members in place after the casting had been trimmed. The work was done with the Milburn combination torch. The contractors on the job had been somewhat doubtful of the



The Quick, Efficient Way of Removing Cast Iron Obstructions

possibility of cutting cast iron in this manner, but were very much interested to observe the ease with which the work was done after the operator had made a little study of it.

NEW WELDING FILM READY FOR G. P. A. CONVENTION

At the last winter meeting of the Gas Products Association there was considerable discussion of the advisability of having the Association produce a motion picture film devoted to oxy-acetylene welding. A definite plan was drawn up and submitted to the Association and it was decided to go ahead with this plan. A committee was formed to take charge of all the details and instructed to produce a film as soon as possible. The committee got into action immediately and prepared a scenario which would tell the desired story, then a commercial moving picture studio was given the job of actually producing the film. For several months they have been working strenuously and patiently at the job, with the result that the first two reels will be ready for showing at the mid-winter conven-

Filming the Gas Welder

tion of the Gas Products Association, which is being held in Chicago this month. The accompanying photograph shows a group of actors, together with some of the committee, assembled at the studio in preparation for a day's work of taking pictures.

It has been the plan of the committee to have this picture available to all members of the Gas Products Association at the least possible expense. Arrangements have therefore been made either to sell duplicates of the film to the members or to loan them at a nominal charge. Copies of the film in both the standard and the small size will also be kept available so that they may be loaned to schools, colleges and engineering associations if desired.

THE OXWELDER'S MANUAL

A complete text book and instruction book for welding and cutting by the oxy-acetylene process. Contents:

Historical Development of Oxy-Acetylene Welding, Oxygen and Acetylene, The Process of Oxy-Acetylene Welding and Cutting, Equipment for Welding and Cutting, Blowpipes—Construction and Operation, Regulators—Construction and Operation, Welding and Cutting Accessories, Cutting, Welding Sheet Steel, Welding Steel Plate, Welding Steel Pipe, Welding Cast Steel, Welding Practices for Cast Iron, Welding Large Gray Iron Castings, Bronze-Welding of Cast Iron and Malleable Iron, Welding Brass and Bronze, Welding Monel Sheet and Castings, Welding Sheet Aluminum, Welding Cast Aluminum, High Carbon Steel and Alloy Steels, Welding Copper, Stelliting, Cutting Heavy Steel Sections and Heavy Cast Iron Sections, Precautions and Safe Practices, Shop Layout and Organization.

216 pages, 120 illustrations. Tables of data on welding and cutting and a complete index. The book is printed on a good quality paper with clear readable type and strongly bound. Copies of the Manual will be available to purchasers of Oxweld equipment free of charge, others can secure copies by addressing the Oxweld Acetylene Company, Long Island City, New York, Chicago, Illinois, or San Francisco, California.

This new book is taking the place of the former publication "Oxwelding and Cutting" which ran through eight editions and although this is marked the ninth edition it is apparent that the publishers have started from the ground up and built an entirely new Manual.

SPECIAL DEMONSTRATION SPEEDS UP SALES

A circular received from the Seneca Electric Arc Welder Company, Seneca, Kansas, tells the story of a special demonstration which was arranged for their electric arc welder in one of the leading welding shops in the city of Detroit. Invitations were issued to a number of men in the city to witness this special demonstration and after they were assembled the machine was put through its paces for their benefit. Mr. W. E. Shafer, sales manager of the company, writes that is a result of the demonstration an unusually large number of orders were immediately secured for the Detroit territory.

DECEMBER MEETING OF INSTITUTION OF WELDING ENGINEERS

At the December meeting of the Institution of Welding Engineers, London, England, which was held on Thursday evening, December 16th, an illustrated paper entitled "Some Features in the Path of a Crack" was read by Mr. G. H. Gulliver. In this paper the author pointed out that a fracture in a metal bar is not instantaneous but begins at a region from which a crack spreads. He then showed that when a round bar is broken in tension it is possible to prove that the middle portion broke before the exterior, so the conclusion is reached that in bars of sound and uniform material, properly held in the testing machine, the tensile fracture starts on or very near the axis of the bar. The natural contention is that a fracture originating anywhere else indicates either that there is a defect in the material or that the bar has been improperly held in the machine.

THERMIT WELDING AT CHICAGO SECTION MEETING

At the January meeting of the American Welding Society, Chicago Section, which was held January 7th, Mr. John B. Tinnon, manager of the rail welding department of the Metal and Thermit Corporation, read a paper on welding with thermit. This paper gave a brief history of the development of the thermit process and followed with a description of the newer methods of using thermit, which have resulted in marked improvement in the quality of the weld produced. The lecture was followed by lantern slides showing a variety of work for which the thermit process was recommended and a motion picture showing every step in a large thermit welding operation. This was followed by a demonstration of the thermit method of welding pipe.

NEW AIRCO GENERATOR CATALOG

Catalog Section No. 5 of the Air Reduction Sales Company has just been issued. This section of the Airco catalog is devoted to illustrations and descriptions of the Airco Davis-Bournonville acetylene generators. These are supplied in capacities of 50 pounds, 100 pounds and 300 pounds capacity in stationary models and a portable model of 50 pounds capacity.

U. S. L. TO OPEN NEW OFFICES

According to Mr. J. L. Fosnight, Sales Manager of the Electric Welding Division of the U. S. Light and Heat Corporation, Niagara Falls, New York, that company is planning to give more and more attention to the market for arc welding equipment during 1927. They plan to engage several district sales managers during the year, who will take charge of various districts which are not at present organized, engage distributors and dealers and give instructions in electric arc welding.

NEWS OF THE WELDING TRADE

"It's a big 1927 we're wishing you" says the International Oxygen to its friends. The message is carried on a 36 x 48 inch poster.

Catalog No. 120 for 1927 has just been completed by the C. H. Hollup Corporation, Chicago, Ill. This catalog is devoted entirely to welding supplies such as electrode holders, face shields, goggles, sand blasts, wire brushes, gloves and fluxes.

F. H. Fahle, formerly proprietor of the Blackwell Welding Company, Toledo, Ohio, has sold his business to Mr. H. O. Dunbar and Mr. L. C. Monroe who have been operating the company since the first of the year.

The Burke Electric Company, Erie, Pa., announce the appointment of Mr. H. C. Lemire, 407 South Fourth Street, Minneapolis, Minn., as district sales agent for Minnesota, North and South Dakota and the northern part of Wisconsin.

The Smith Welding Equipment Corporation has just issued a new two color folder describing the Smith preheating torch and calling attention to the great variety of uses for the oil burning torch operated with compressed air.

The Advantages of Tobin Bronze Welding

ANACONDA
from mine to consumer

Tobin Bronze is unequalled for welding cast iron by the oxy-acetylene process. It has the following advantages:

The base metal need only be heated to a dull red as Tobin Bronze flows freely at 1650° F.

This low welding temperature eliminates special pre-heating and often makes dismantling unnecessary.

Shrinkage can be prevented and the original alignment of broken parts retained.

And most important of all, Tobin Bronze is stronger than cast iron.

Tobin Bronze Welding Rods are made solely by The American Brass Company and "TOBIN BRONZE" is stamped in the metal.

THE AMERICAN BRASS COMPANY
GENERAL OFFICES: WATERBURY, CONNECTICUT
Offices and Agencies in Principal Cities
Canadian Mill: Anaconda American Brass Ltd., New Toronto, Ont.

TOBIN BRONZE
REG. U.S. PAT. OFF.
WELDING RODS

A Real Combination—the Wodack

The Wodack Combination Portable Electric Drill and Grinder is a real combination tool, built for hard service. The repair shop needs both tools and saves money by getting the two in one. The convenience of carrying this handy tool to the work results in further savings. And it's guaranteed. Our book "Electric Tool Facts" tells what a drill and grinder ought to be. Send for your copy.

Wodack Electric Tool Corporation
43 S. JEFFERSON ST., CHICAGO, ILL.

"WODACK"
Combination Portable
Electric Drill and Grinder
Patented Nov. 1, 1921

The Burdett Manufacturing Company, Chicago, Illinois, moved its factory and general offices from 306 St. Johns Court to 15 N. Sheldon Street, Chicago, Illinois.

At the meeting of the Institution of Welding Engineers held at Caxton Hall, Westminster, London, on Monday, November 29th, Mr. J. H. Paterson read a paper entitled "Thermal Disturbance in Iron and Steel During Welding." The paper was illustrated by lantern slides.

Classified Ads

Help Wanted—75c per line, minimum 4 lines.

Jobs Wanted—4 lines free.

Other Ads—$1.00 per line, minimum 4 lines.

Counted 8 words to line. Add 6 words for keyed address.

Notice—So far as we know no machines of ours are on the second hand market. If there is anybody that has one of our machines that is not in active use we will be glad to buy it back from them. Electric Arc Cutting & Welding Co., 152 Jelliff Ave., Newark, N. J.

Wanted—Position as acetylene welder, demonstrator, or salesman. Sold, demonstrated and installed acetylene welding equipment for over eight years. I hold patents on welding and cutting torches that are free. Address 105, care The Welding Engineer.

For Sale—5 DC-DC Lincoln Welders. In very good condition, available for immediate delivery Manhattan district. Terms if desired. Phone Murray Hill 6377 or write 1039 Grand Central Terminal Building.

Rebuilt and Traded-in Machines for Sale—At a bargain, both motor generator sets and transformer welders. These machines are sold guaranteed free from mechanical and electrical defects and satisfactory operation is warranted. Prices in general are about half the new price. Performance is 100% or no sale. Electric Arc Cutting & Welding Co., 152 Jeliff Ave., Newark, N. J.

For Sale—Service Rights on W. K. and W. C. Prest-O-Lite cylinders, large or small quantities. Alfred E. Corp, 40 Mathewson Street, Providence, R. I.

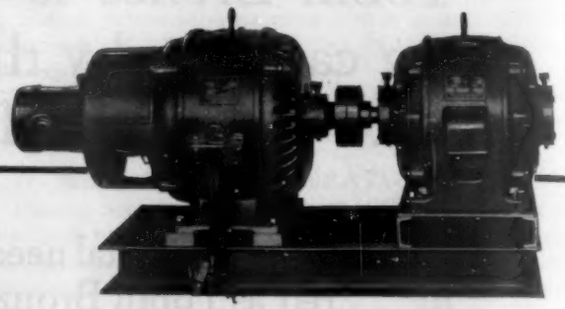
For Sale at a Bargain—3000 lbs. 5/32 in. by 14 in. High Carbon Coated Electrodes, conforming to American Welding Society specification E-No. 1 C. 4000 lbs. 5/32x14 in. 3000 lbs. 1/8x14 in. Low Carbon bare annealed Electrodes. Carbon .10 Maximum—Manganese .35 to .55—Sulphur and Phos. .04 Maximum. Write for special prices. James E. Ferguson Company, 1597-99 Main Street, Buffalo, New York.

For Sale—1 General Electrode Motor Generator 100 Ampere Direct Current Welder. 1 C. & C. Motor Generator 150 Ampere Direct Current Welder. Both sets mounted on hand trucks, reconditioned and guaranteed. U. S. Welding Co., Inc., New York City.

WELDING SUPPLY DEALERS

Do your customers know how best to use the apparatus you sell them? The best way you can serve them in this respect is to furnish them The Welding Engineer, and The Welding Encyclopedia. Write for our plan.

The Welding Engineer Dealers Service Dept.
608 S. Dearborn St., CHICAGO



No External Stabilizer on the

HANSEN
ARC WELDER

In the Hansen Arc Welder the stabilizing effect is obtained without adding any windings to those ordinarily employed in commutating pole machines. The resulting advantages are: (a) Saving of energy and lower operating cost, (b) lower maintenance cost, (c) less weight and greater portability, (d) and better penetration, with positive arc stability.

NORTHWESTERN MFG. CO.
Clinton and Madison St. Milwaukee, Wis.

Prepare the Work and Smooth the Welds with

MALL
Portable Electric and Flexible Shaft Tools and Grinders

MANY TYPES AND SIZES

MALL TOOL CO.
8385 S. Chicago Ave. Chicago, Ill.

Weldite

Welding Rod

SUPERINTENDENTS—SUPERVISORS —WELDERS

You can keep posted on all the new developments in welding rod if you request your name placed on the mailing list to receive free copies of all Bulletins published by the

Research Department

CHICAGO STEEL & WIRE Co

103rd Street *and* Torrence Avenue CHICAGO

HOLLUP ELECTRODES

"ARE SO MUCH SUPERIOR"

Read what one of our distributors says:

"The _____ Company have again signed up for Wanamaker No. 3 Electrodes for the year, 1927. Mr._____, the Superintendent states that of all the rods they have used in the past this is so much superior that he feels grateful to Hollup Corporation and ourselves for causing him to adopt this line."

Wanamaker Coated Electrodes

Rex Process Bare Electrodes

Rex Oxy Acetylene Welding Rods

Rex Welding Supplies

Write for Samples

C. H. HOLLUP CORPORATION

3333 W. 48th Place **CHICAGO, ILL.**

HARMLESS Arc Welding Apparatus

Portable, compact, efficient

Simply constructed and easily manipulated. Arc is quiet and uniform. Constant voltage varying from 25 to 28 volts. Can be connected to any 110-volt d.c. circuit.
No wearing parts. Purchase cost is only cost. Successfully demonstrated at the recent Power Show in New York City.

Recommended for
Iron and steel welding and for general welding of metals.

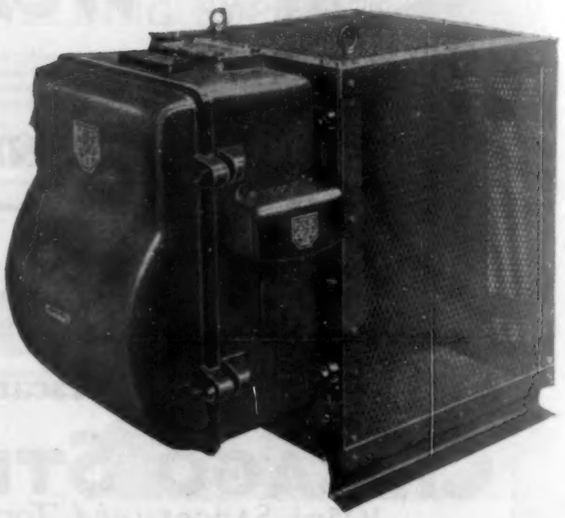
For use in
Factories, plants, repair shops, on steamships, etc.

HARMS SYSTEM ELECTRIC WELDING CO.

342 Court St., BROOKLYN, N. Y.

SUCCESSFULLY AND EXTENSIVELY USED IN VARIOUS COUNTRIES

Service demonstration on request.
Send for detailed information.



Harms System Welding Apparatus (Weight, 600 lbs.; Dimensions, 21x22x30 Inches.)

For non-porous and permanent repairs use the

WELDENE

PROCESS

Distributors

BURDETT OXYGEN CO.,
30 W. 4th St., Oklahoma City, Okla.
PROGRESSIVE WELDER SALES CO.,
1025 N. 6th St., St. Louis, Mo.
SCHROEDER & SON,
11 N. 2nd Ave., Maywood, Ill.
TORCHWELD EQUIPMENT CO.,
224 N. Carpenter St., Chicago, Ill.
COMMERCIAL ACETYLENE & SUPPLY CO.,
600 W. Jackson Blvd., Chicago, Ill.
BURDETT OXYGEN CO.,
216 Ivy St., Atlanta, Ga.
NICHOLS, DEAN & GREGG,
St. Paul, Minn.
BURDETT OXYGEN & HYDROGEN CO.,
15 N. Sheldon St., Chicago, Ill.
GRAND RAPIDS WELDING CO.,
340 Division Ave., S., Grand Rapids, Mich.
WELDIT ACETYLENE CO.,
638 Bagley Ave., Detroit, Mich.
NATIONAL WELDING & MFG. CO.,
1418-1430 Niagara St., Buffalo, N. Y.
HAMILTON WELDING CO.,
100 Mary St., Hamilton, Ont.

WELDENE is not new, or untried. It has been on the market for seven years and has proven in service every claim made for it by the manufacturers. It has passed rigid laboratory tests in some of the largest industrial plants.

A list of our distributors is given at the left. These nationally known firms sell and recommend Weldene. Send for our new folder which lists the uses for Weldene.

The Weldene Corporation
608 S. Dearborn St.,
Chicago, Ill.

If its CARBIDE — Ask for NATIONAL

BEST for All Industrial Purposes

—

IN THE RED DRUM SAVES YOU MONEY

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Warehouses in All the Principal Cities

National Carbide Sales Corporation, 342 Madison Ave., N. Y.

Roebling
Welding Wire

is uniform in quality throughout the same shipment and throughout all shipments. It is giving utmost satisfaction wherever used and is guaranteed to make perfect welds with the least amount of trouble in welding.

Low Carbon—
Standard High Carbon—
Special High Carbon—
Special High Manganese—
Gas Welding Wire

John A. Roebling's Sons Company
TRENTON, NEW JERSEY

OXECO

Seamless Monolithic filled acetylene cylinders have successfully undergone practically every conceivable kind of a test in actual service. The result has always been the same, namely, 100% safety.

The truly seamless shell made entirely from one piece of carefully selected steel always will remain in one piece regardless of heat, pressure or other conditions.

Monolithic filler with a crushing strength of several hundred pounds per square inch cannot weaken, sag or deteriorate.

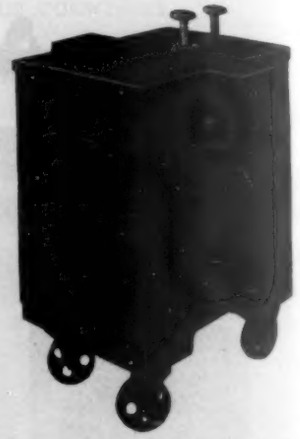
Leading acetylene producers and many acetylene users who have investigated the matter of cylinder construction now ***specify seamless monolithic filled acetylene cylinders.***

KEITH DUNHAM COMPANY

110 South Dearborn Street
CHICAGO, ILL.

Small Shops Grow Into Big Shops

by using the
NEW IMPROVED
SENECA Electric ARC WELDER



The low operating cost of arc welding doubles profits even when prices are reduced. Put a Seneca Arc Welder, to work in your shop and you'll soon learn what a profit can be made in your business. Don't worry about the cost—our convenient terms take care of that problem. Write for details of our plans.

Seneca Electric Arc Welder Co.
Seneca, Kansas

Gas SEACO **Arc**
TRADE MARK
Welding Rods

HIGH CARBON ELECTRODES
FOR
SURFACE TRACK WELDING
SIZES
5/32", 3/16" and 1/4"x18" and 36"
LENGTHS
DEAD, SOFT ELECTRODES
SIZES
5/32", 3/16" and 9/32"x24" LENGTHS

Samples on Request
"It isn't only the analysis that counts!"

STULZ-SICKLES CO.
IRON & STEEL PRODUCTS

Immediate Shipment From Cleveland and Newark Warehouses

125 LAFAYETTE ST., NEWARK, N. J.

Uniform Quality Assured

WELDERS who use Commercial Acetylene soon learn that every cylinder contains the same pure gas.

Your torch can tell the difference!

COMMERCIAL ACETYLENE
Means pure acetylene.

COMMERCIAL SERVICE
Means prompt service.

No matter what your gas requirements may be you will be interested in our sales plan. Ask our nearest office to tell you about it.

Supplied in the following size cylinders:

10x30-in. size	- -	125 cu. ft. cap.
12x36-in. size	- -	225 cu. ft. cap.
12x44-in. size	- -	275 cu. ft. cap.

Commercial Acetylene Supply Company, Inc.

General Office: 80 Broadway
New York City

BRANCHES:

80 E. Jackson Blvd. Chicago, Ill.
613 Trust Co. of Georgia Bldg. Atlanta, Ga.
683 Atlantic Ave. Boston, Mass.
417 Market Street San Francisco, Calif.

75 to 450 Ampere Welding Current Range with Una Welders

Ample welding current is one of the most essential factors in good welding and in the speed of welding.

The most satisfactory welding current varies with the nature of the work, the diameter and type of electrode and the skill of the operator. With a range of 75 to 450 amperes, UNA Welders deliver the necessary current no matter what the needs of individual jobs may be.

UNA Welders meet every type of welding from the thinnest metal sections to the heaviest structural steels and castings by either the metal or carbon arc process of welding.

Built on the Dynamotor principle, UNA Welders are compact and rugged. They offer the highest capacity per unit weight of welder on the market.

Available in single or double operator units

Una Welding Rods

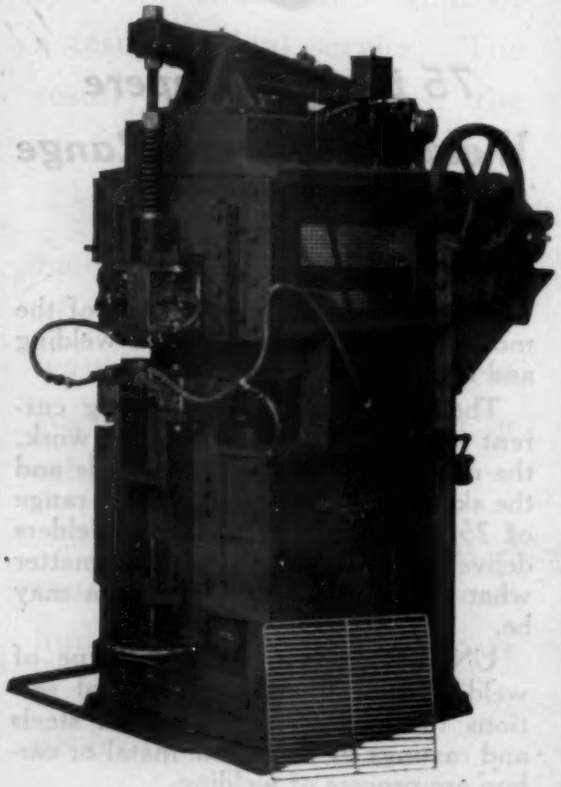
A complete line of coated rods for A. C. and D. C. arcs, for light and heavy duty welding, for copper, bronze, steel and cast iron.

Una Welding and Bonding Company
Cleveland, Ohio

UNA Welders
Welding Rods

10 Welds in 10 Seconds

With this heavy duty automatic spot welder, cross wire welding of refrigerator racks is done uniformly and at an amazing speed. Why? Because we were able to design the machine to make the ten spot welds at one operation.



Type 612-B Automatic Spot Welder

WHENEVER we find special production problems we design special welding machines to fit them. If you think your work is "different", remember that our engineers have developed special welders for hundreds of "different" requirements. It is worth your while to investigate this service.

Federal

Machine & Welder Co.

WARREN, OHIO

U. S. A.

Recognized leaders in the development and construction of all types of resistance welders.

Dixon's Graphite Rods and Plates for Welding

Made in all diameters, lengths and sizes.

Small diameter rods are sold in 4, 6 and 8 inch lengths, the shorter the rod the less breakage in shipping.

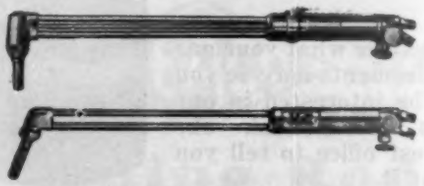
Also Dixon's Graphite Welding Putty. In 5 and 10 lb. cans.

Dept. 202A.

Joseph Dixon Crucible Co.

JERSEY CITY, N. J.

1827— ONE HUNDREDTH ANNIVERSARY —1927



K-G TORCHES REGULATORS COMPLETE UNITS

K-G WELDING AND CUTTING CO., Inc.

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All Page Armco and Page Steel welding wire and electrodes are processed and shop tested for the work they are best suited to. All plainly marked for identification, thus eliminating guess work.

Write today for samples. Test them in your shop under any condition. Please specify the exact type of welding the wire or electrodes will be placed to. You will not be obligated.

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District Offices:
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PROCESSED
Welding Wire *and* Electrodes

Imperial

No. 11 Outfit $90

A Complete New Line of Oxy-Acetylene Welding *and* Cutting Equipment

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There are other new Imperial Outfits, too. Write for the new Imperial Catalog No. 314.

Imperial Welding and Cutting Outfits are packed in substantial light steel carrying cases.

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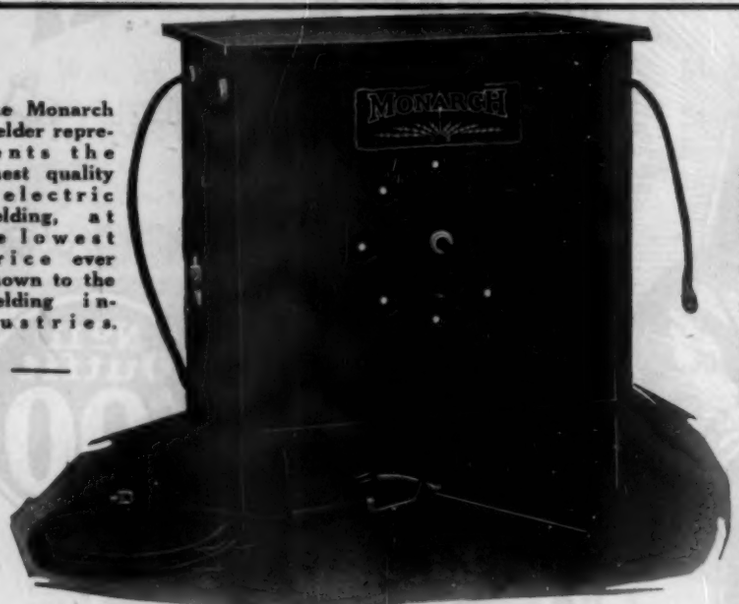
The Monarch Welder represents the finest quality in electric welding, at the lowest price ever known to the welding industries.



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Guaranteed Quality and Performance

The air Cooled Light and Heavy Duty Arc Welder

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Stable Arc.

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Single Operator and Two Operator Machines

for electric motor, gasoline engine or belt drive and for either stationary or portable service

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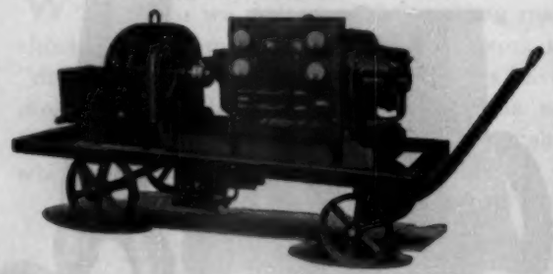

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The Ideal Apron for Welders is made of leather which has been especially treated to stand the heat, and at the same time be very flexible and durable.

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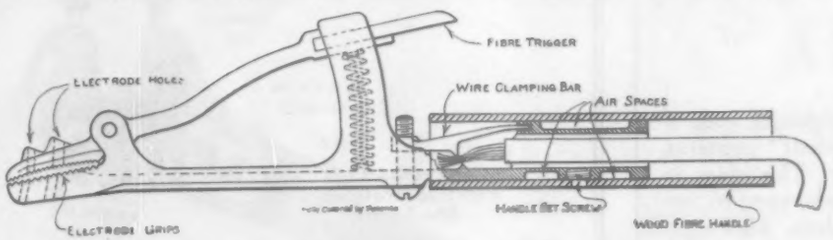

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Firm Grip. *Quick Release of Stub End.*

Price

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HOLDER and 5 ft. of Extra Flexible Cable $7.25

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THE UNIVERSAL FLUX

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Try a can of this perfect flux on your work.

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Proposition open to salesmen calling on jobbers and large users.

FOR SALE

FIVE new General Electric Gas Driven Arc Welding Sets, with 20 H.P. Continental Red Seal Four Cylinder Gas Engine and General Electric WD-11 Generator of 250 amperes capacity. Net weight, 2000 pounds.

PRICE, $1200.00

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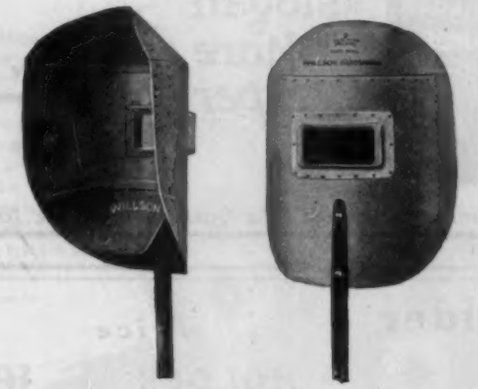
Willson Handshield No. 1 for Good Electric Welding



A well balanced black fiber handshield with a good grip fiber handle. A "chin shelf" protects the eyes from underneath flashes. The glass is Willson "Industro" with cover glass, easy to replace. Price of handshield complete, $6.75.

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Standard Seamless Steel Cylinders

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The more you know about the Gas Welding and Cutting Equipment the more emphatically you will class TORCHWELD Value alone and unapproached in the entire Oxy-Acetylene field.

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ALMANC
METALLIC
ELECTRODE HOLDER

Most Simple—Most Efficient—Metallic Electrode Holder Yet Developed.

There are no springs to lose tension for the grip is positive through both jaws. Careful construction has reduced heating to a minimum, while the operator is at the same time fully protected from shocks. It is simple to quickly insert and release the electrodes, which can be used with very small amount of waste. Its construction permits the removal or replacement of the holder cable with only the aid of a screw driver—it is not necessary to use soldering. All of these exclusive features make the Almanc Metallic Electrode Holder a wise buy.

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Gas Weld and Electro Weld Rods

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IRON STEEL QUALITY SERVICE
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Satisfactorily solves the lighting problem. Shoots straight to the spot. Stands up under rough usage.

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Our No. 11 Shield, especially for welders who wear correction glasses. You will enjoy the comfort and freedom afforded by it.

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No Ultra Violet — Absolute Shade Values
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ELKONITE

Draw Your Own Conclusions

The remarkable service that Elkonite Welding Electrodes give can best be appreciated by this plain comparison between Elkonite and the material that it replaced in a number of typical operations.

Operation	Previously Used Material	Elkonite
Radio panels	100 welds	8,000 welds
Brass radiator shells	16,000 welds	400,000 welds
Wire to heavy metal	300 welds	12,000 welds
Motor frame assembly	15 welds	400 welds
Wire to tin plate	50,000 welds	2,500,000 welds (incomplete)
Galvanized steel wire	15,000 welds	225,000 welds
Roller bearing assembly	24,000	400,000

Elkonite Welding Electrodes remain hard, *without mushrooming*, under red heat, great pressures and heavy electric currents.

They have made the spot welding of brass, tinned iron, galvanized iron and aluminum commercially practicable.

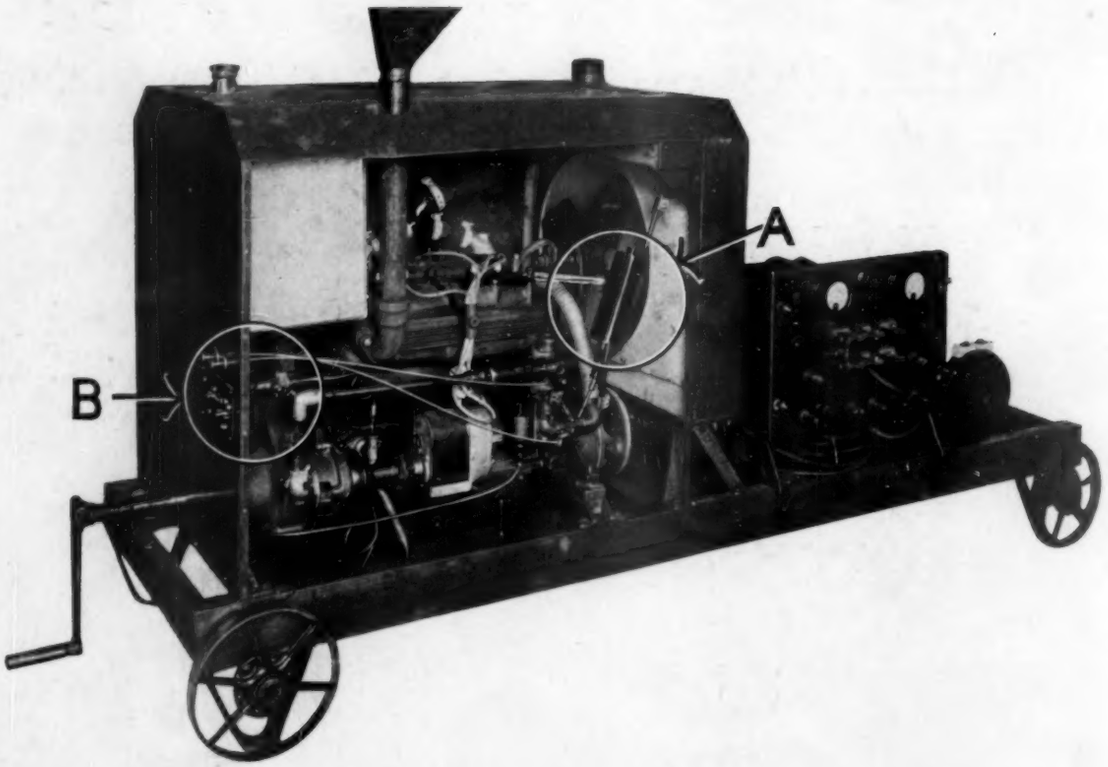
Especially recommended for severe conditions such as hot upsetting rivets electrically, in facings for clamps for rod welding, split dies for welding steel spokes to both hub and rim of steel wheels, and all classes of flash welding.

WHEN HARD DRAWN COPPER FAILS
: : : YOU CAN DEPEND ON ELKONITE

ELKON WORKS Inc.
Subsidiary of P. R. Mallory & Co. Inc.
Weehawken, N. J.

Exclusive licensees under General Electric Co., patents dated May 28, 1925 and Sept. 1, 1925. Other patents pending to Elkon Works, Inc.

When you buy a *"DUALARC"* Gas Engine Driven Generator —



—you get an engine *that can give you arc welding service!*

For example—

The part marked "A" in the photograph above is an automatic electric governor which is included on our machine in addition to the mechanical speed governor. This device allows the engine to idle when the arc is broken. The engine speeds up automatically without the use of any push-buttons, switches or wires. The result is a saving of gasoline and a reduction of strain on the engine and the rest of the eqiupment.

"B" in the photograph is the inter-locking ignition oiling system. If the oil is too low or if the oil pump fails to operate for any other reason the magneto stops operating. Also there is an extra gallon of oil outside the crank case which is automatically fed to the crank case when the oil level becomes low.

In addition to these exclusive features of this engine we have for our own protection supplied an air cleaner so that no air except filtered air can get in, and an oil vapor remover.

When you buy the Dualarc gas engine driven set you not only get a generator which will deliver welding current for every possible arc welding need but you get a gasoline engine with it which is specially equipped with exclusive features, incorporated in the engine, to prolong its life and adapt it to the highest degree of arc welding service.

Electric Arc Cutting & Welding Co.

152-153 Jelliff Avenue

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